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COVER: This interesting and colorful group of fossils includes (from left, clockwise) a fern, several ammonites, fossiliferous matrix, coprolite, a shark's tooth, a turritella and a trilobite. Fossils courtesy of Bourget Bros. Photo by Earl Lewis.

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Rock&Gem

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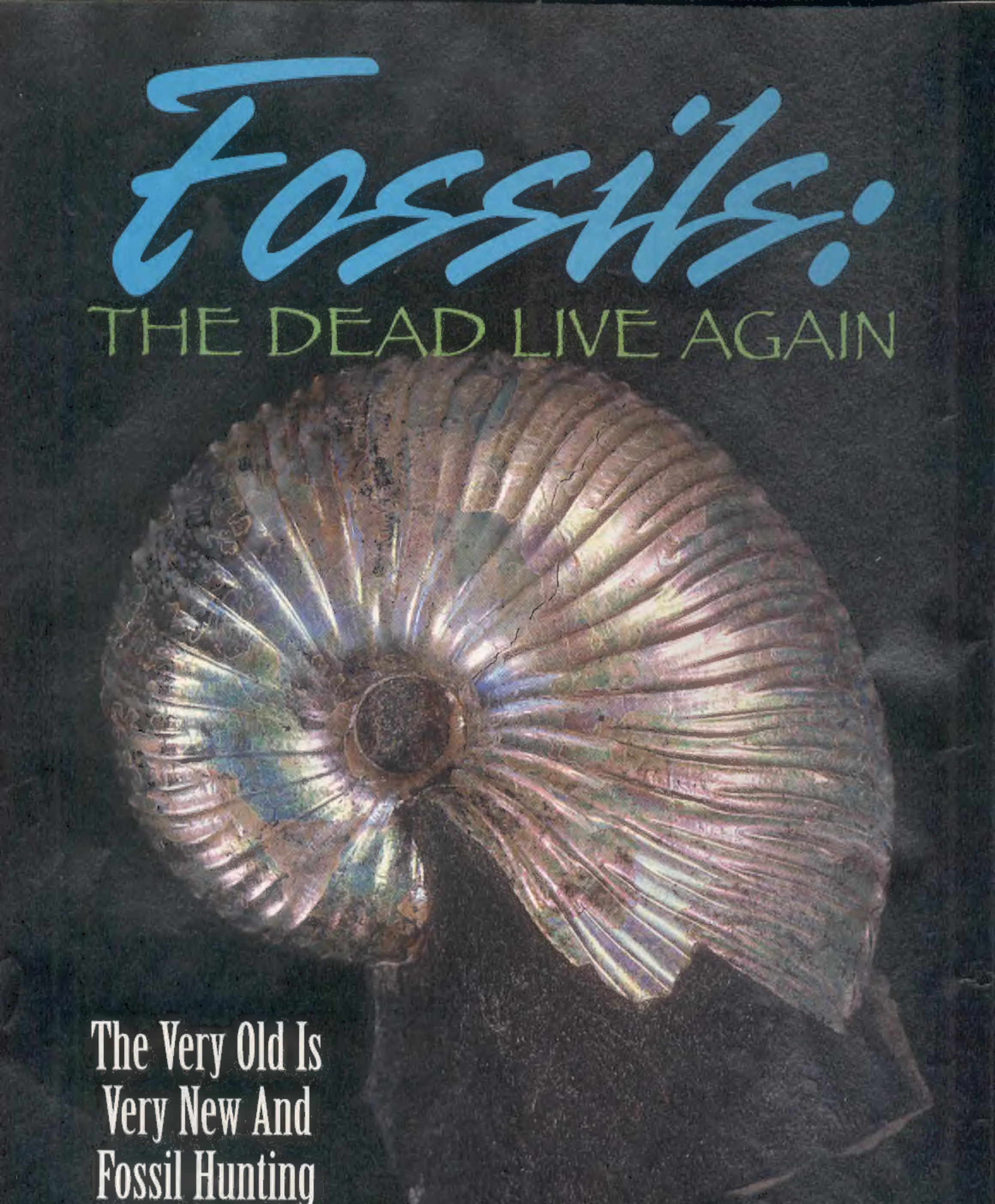
Fossils:

THE DEAD LIVE AGAIN

The Very Old Is Very New And Fossil Hunting Thrives



Sometimes the shell of an ammonite fossil takes on a spectacular rainbow of colors, making it a superb display specimen. Photo by Jeff Kurtzeman.

by Bob Jones

One of the exciting trends in the natural sciences is the remarkably high interest now being shown in fossils. We've always had fossil collectors, starting with Mary Anning, who dug the first plesiosaurs at Lyme Regis in southern England (an event described in Geoffrey Notkin's lyrical tale, elsewhere in this issue).

Ordinarily, the collecting of fossils was reserved strictly for scientists or well-to-do amateur naturalists until the last half of this century. In that short time, fossils have entered the worlds of home and office decor, while attracting thousands to a hobby that is both fascinating and rewarding.

Today, natural history galleries abound. They offer the nature lover amazing rock masses handsomely filled with curling ammonites, twisting baculites, skulls of long-extinct creatures and the exoskeletons of creatures, called trilobites, that lived hundreds of millions of years ago.

Size seems to be of no consequence in fossil displays these days. You can obtain slabs of rock several feet across with beautifully polished fossils in high relief, which have been carefully prepared for maximum impact. At the same time, it is not unusual to find the skeleton of a 15-million-year-old fish displayed over a mantle in a home, where a mounted sailfish once hung.

Even furniture has been invaded by fossils; slabs of fossil-laden rock have been shaped, polished and mounted on legs to make end tables and coffee tables. Lamps and vases have been shaped from rock rich with fossil remains that stand out in stark contrast to their dark rock matrix.

You can even find entire buildings constructed now, using fossil-rich limestone rock. In fact, walls in office buildings are being veneered with huge slabs of rock that contain coiled ammonites and the remains of seashells and other inhabitants of the deep.

Just where and when this sudden fascination for ancient life began is difficult to say. Amateur naturalists and collectors have always cherished the remains of ancient creatures. When fossils were found by ancient peoples, however, they were thought to be tricks played by the devil to deceive and test the faith of true believers. Another early explanation was that all fossils found were forms of life that had been killed in the Great Flood in which all creatures perished, according to the Bible, except for those aboard Noah's Ark.

Once fossils were identified as the remains of past life on Earth, it was not unusual, 200 years ago, for a wealthy person to have a "natural history" cabinet in his mansion: a cabinet replete with mineral specimens, meteorites and the fossilized remains of some extinct creature. But such collectors were an elite group, limited by wealth and the time to establish a private collection.

continued on next page

Dinosaur eggs from China stirred tremendous interest when they first were discovered a few years ago. The Chinese finally had to put a stop to the export of these eggs. (Los Angeles County Museum)

This beautifully prepared group of ammonites was displayed by Julie's Rock Shop at a recent MSSC show.

This huge slab is typical of the fossil decor coming from Morocco these days. The fine white lines are chisel marks, made during the removal of excess matrix.

Fossils/ *from page 13*

Today, everyone is fascinated by fossils. Fine fossils are readily available at prices within the reach of any collector. As a result, fossils are found in abundance at mineral shows and even at swap meets. The lapidary has taken to fashioning jewelry with a coiled pyritized ammonite or a trilobite as the center stone.

The public's interest has been nurtured by several things. There has been a growing appreciation for the environment and past life on Earth. Now, the dinosaur, insects in amber and other extinct creatures as the subjects of popular science-fiction movies—think of *Jurassic Park*—have added to the public's fascination with extinct creatures.

Recent fossil discoveries have come in many forms. The now-famous find of large numbers of dinosaur eggs in China in the last decade caused plenty of interest and excitement. Currently, a vast deposit of marine fossils in grey limestone is being worked in Morocco; wonderful display fossils from there have flooded the marketplace with extremely attractive fossil examples, and in a wide range of sizes and prices. This material can be slabbed and polished, then used as huge, free-standing exhibits.

The rapid growth of paleontology as a hobby has brought to light whole skeletons of turtles, reptiles, fish and the like—a large majority of them discovered by amateurs. Some of these creatures are so huge that they can only be displayed in a museum or the atrium of a large office building.

Some individuals have gone to considerable expense to incorporate fossils into their homes. I know of one enterprising Japanese collector who bought a complete plesiosaur skeleton, a huge creature that haunted the vast oceans during the Age of Dinosaurs. Instead of displaying the monster in his front hall, he had the skeleton mounted in the wall over his bathtub so it would shimmer in its watery environment as he bathed!

Keep in mind that, for years, collectors have had ready access to some common fossils: the trilobites of Ohio and Utah; fern-imprint fossils from the Pennsylvania coal beds; fossil fish skeletons from the Green River Formation of Wyoming; even dinosaur footprints in the Connecticut River Valley. These were common enough in the old days to arouse excitement only in the minds of the dedicated fossil collector. For the rest of the collecting world, they were curiosities of passing interest. Not so today!

Some fossil remains, like the ammonite shells from Canada which flash a rainbow of colors, have entered the gem world and have found acceptance among creative artists. Other fossil remains that have been replaced by the brassy mineral pyrite make wonderful jewelry. Geometrically intricate, coiled, pyritized ammonites are particularly popular.

People who enjoy stringing beads have discovered the disc-like sections of crinoid fossils. They look like small doughnuts—ideal for stringing, along with other beads. Certainly one of the most graceful fossils is a complete crinoid: a plant-like creature with a long graceful stem anchored to the ocean floor, and a head that crowns the stem like a flower. In fact, these have often been thought to be a form of plant life by people who see them for the first time. A complete crinoid, properly prepared, is among the loveliest of fossils for display.

Fossils are generally thought to originate from two sources or environments. The limestone rocks that form in the waters of the world preserve ancient sea creatures—primarily, the shells and hard parts, which survive dissolution.

Since limestone tends to form in quiet waters (i.e., without fiery violence), fossils have a much greater chance to form and survive.

The same is true of sedimentary rocks of the dry land. As land creatures and plants died, they could be buried in rapidly forming sediments, which later solidified as layers of rock—for the most part, just the hard parts of once-living creatures, generally bones and teeth. In rare instances, volcanic ash can settle back to Earth and enclose leaves, twigs, insects and other relatively fragile life forms and preserve them.

Igneous rocks, since they form under extreme heat, almost never show recognizable evidence of past life. The same is true of metamorphic rock, which may have been a fossil-bearing sedimentary rock until it was subjected to extreme heat and pressure, which distorted and destroyed its fossil contents.

The lapidary takes full advantage of some fossils. Think of all the lovely objects you've seen made from colorful agatized wood. And how about opalized wood, like that from Virgin Valley, Nevada? Then there are the palm roots, dinosaur bones and the like that have been replaced by colorful quartz to give us choice agates and patterned gems. Certainly, such fossil remains have had a major impact on the lapidary and jewelry scene in recent years.

Finding fossils can sometimes be relatively easy. Just keep in mind that, on private and federal lands, fossils are protected like anything else. Getting permission to collect is always the wise first step. If you can find a nice fossil-rich horizon, it's always a great place to take kids to collect. My son and I often enjoyed collecting leaf imprints in abundance in the western Pikes Peak region and brachiopods in the Midwest. If we were lucky, we'd find the imprint of a small insect, like a bee, revealed when we split the thin layers of volcanic ash in the Florissant, Colorado, area. And it seems almost every roadcut in the Midwest still yields fossils.

Conditions have to be just right for fossils to be preserved and, once formed, protected until they are discovered. Some, like petrified wood, are hardy enough to withstand exposure to the elements for years. Others, like delicate insect fossils, may be lost almost as soon as they are exposed by weathering.

Collecting fossils is decidedly different from collecting minerals. For one thing, minerals tend to be found concentrated in deposits, an ore vein, a mineralized seam or an alluvial concentration of gravels, the source of so many superb gems. Fossils, on the other hand, are more often scattered over a large area, or in a rock horizon that extends for hundreds of feet, requiring great effort and much luck for someone to find a superb example. Yet, as with minerals, extracting or obtaining a specimen is only the first, and sometimes painful, step to the final product.

Preparation of the fossil, once found, is perhaps the more difficult task. You may be dealing with something very fragile, easily damaged, and, sometimes, with only a trace or vestige of the original parts. Working with great care, fossil preparers use everything from camel's hair brushes to small impact tools to chip away the enclosing rock and reveal the remains.

The recent development of air abrasives using glass or plastic beads, microimpact tools which can be controlled like a surgical instrument, and the new glues and preservatives, have all contributed to improved chances of successful fossil preparation.

Even when working with something as large as a dinosaur fossil, care is essential, as any careless slip may destroy evidence that could prove invaluable to the researcher. It's amazing how one small bone or incised pattern on a bone can help a scientist determine something of critical importance in visualizing the animal that lived millions of years ago.

The study of fossils has been critical to our understanding of the earth and evolution. We have also been able to use certain "marker" fossils to identify rocks of the same age, though they may be hundreds of miles apart. It was the study of certain fossils that aided scientists in tracing and establishing the age and sequence of rock layers, as they developed the science of geology over 100 years ago. Fossils found where the rock formations could be dated, and then found elsewhere in rocks of unknown age, gave scientists the ability to establish the ages of the second formations. In this way, a sequential arrangement of the major rock formations of the Earth could be developed.

continued on next page

Utah's best-known source of ancient trilobites is Antelope Springs, where collecting (with permission) is possible. Photos by author.

Fossils/ *from page 15*

Earlier, I mentioned the volume of dinosaur eggs that have come from China. The Chinese government finally had to put a stop to the export of these eggs. China was losing some of its life history. Some of the eggs retrieved were particularly fascinating; they contained the skeletal remains of baby dinosaurs that died unhatched, perhaps because the eggs were buried during a sandstorm or natural disaster.

Plant and animal remains are not the only fossils sought by paleontologists. Human remains are, undoubtedly, the most exciting fossils of all. To say that they are rare is an understatement. Yet, scientists are diligently searching regions where early man once lived. The caves of Europe have produced remains of Cro-Magnon Man, our most immediate ancestor. The same region produced fossil remains of another hominid called Neanderthal, so named for the German valley were this species was first unearthed.

The most exciting region on Earth being searched today for hominid remains is the Afar Triangle region and the Great Rift of East Africa. Here, partial remains of hominids as ancient as 3 million years old have been found. Fossils footprints on a prehistoric lakeshore, partial skulls, leg and arm bones, even crude tools used by these erect walking ancient hominids have come to light.

Unfortunately, when scientists deal with fossil remains that are so old, specimens that have often been partially destroyed by weathering or that have been scattered through eons of time, they never find a complete skeleton. So, conclusions are always open to question. For this and other reasons, the outline of the evolution of hominid life on Earth is sketchy, at best.

If you are a collector, be it of minerals, marbles or stuffed dolls, you can't help but be stirred by the evidence of early life on Earth. With modern preparation techniques and the renewed and broadening interest in fossils, as well as readily available examples from all over the world, superb specimens of many of these ancient life forms are available. They are fascinating just displayed on a shelf, and even more fascinating when used as personal adornment or home decor. They are great conversation starters, giving you another aspect of our natural world to find interesting while providing you with yet another source of knowledge and pleasure.

Maybe you'll get lucky like a certain fossicker in Australia, who was hunting opals. In 1987, he was digging away when some fine precious opal bits began showing up. As more and more of the opal was uncovered, an opalized skeleton of a sea creature called a plesiosaur was revealed. Nearly 500 hours of preparation were required to expose the skeleton in all its fiery glory. Much of the opal was potch but there was enough flash of color to make this ancient creature a glory to behold. Not every fossil hunter is so fortunate but, for most of us, the hunt is the thing. So go for it!

Shop Talk

William A. Kappele

Bits Of This And That

As a card-carrying member of Packrats Anonymous, I have always been loath to throw anything away that looked like it might be of use someday. Since I have so many hobbies, that means virtually everything falls into this category! Following are some of my invented uses for those little bits and pieces that rock hobbyists seem to accumulate.

At one time, I had a secretary who was fascinated by the little bits and chips gathered from around my trim saw after cutting cab preforms. I used to save them until I had a baby food jarful, then take them in to her. She displayed them on a mantle or coffee table.

This isn't a bad idea, but how about a couple more steps? Put the chips in a jar of mineral oil to bring out the colors, and use a decorative bottle instead of the baby food jar. You could even use the type of fancy bottle with a cork stopper and make a decorative stone top for the cork.

I am no expert on aquariums, but I've noticed the colored gravel used in many of them. Maybe some of the trim-saw chips could supplement or even substitute for the gravel.

If aquarium gravel doesn't grab you, how about clear casting resin? (*That* grabs just about anything!) There are molds, in all kinds of sizes and shapes, available in craft stores. A nice half-dome filled with colorful chips would make a great paper weight for any rockhound's desk. Thin, transparent slabs cut from small pieces can be cast flat in resin or cemented to glass in patterns that simulate stained glass.

Try using small transparent slabs as earrings or pendants ... with or without mountings. If you mount them, be sure to use open mountings with no backs. This will allow the light to shine through.

For a really unique gift, why not try a custom picture frame? Just pick up a dime-store frame (or a very expensive one if you are so inclined). Remove the back and the mat, if there is one. Now cement small thin slabs around the inside perimeter of the glass in any shape or pattern you desire. Fit a thin mat in an appropriate color behind the slabs, insert your favorite photo and put the whole thing back together. Bingo! Instant gift success.

Belt buckles are always a good bet because they can be done in so many styles, sizes and shapes. I made one of scraps cemented into a cast-brass buckle blank.

I found some of these blanks in several sizes and shapes at a show a few years ago. Unfortunately, I am running out of them now, and I've had virtually no luck in locating the manufacturer. On the back of the buckles there is a small logo which says BTS Group—1991—Made in USA. I've called all over and even surfed the 'Net, trying to find out if they are still in business, and if they are, where they are. No luck. If any of you know the answer to my problem, please write and tell me.

Now, back to making the buckle. Of course, you don't need a cast blank like the one I used. There are a wide variety of blanks on the market that will do just as well. If you are a silversmith, you can fabricate or cast your own.

Once you have decided on the buckle blank, it is time to think about the design of the stone pattern. Much of the design and construction will depend upon the shape you choose for your blank. A round or oval shape will require more careful layout than a square or rectangle. After all, you don't want tiny or uneven pieces at the edges.

There are several methods you can use to lay out and glue the pieces. One is to begin by sketching the basic design on a piece of heavy paper or card stock. You can then cut the pieces and dry-fit them before gluing. You can also just start cutting and fitting pieces on the blank itself. The problem here is that you have to be careful not to end up with tiny pieces at the ends, top or bottom.

Still another method is to use a thin slab of "leaverite," or waste stone, for a backing. This way, it is possible to assemble the parts and grind the whole "sandwich" to fit the blank.

For a quicker job, you might want to use your scraps just as they are and make a true mosaic. This will save *some of* your sanity by eliminating the time-consuming steps of carefully fitting each piece to its neighbors. (I can't be responsible for the *rest* of your sanity. Sorry.) To finish off the mosaic, you can make a grout of rock dust and epoxy, that can be ground off in the finishing steps.

Finally, you might want to leave the pieces at unequal thicknesses. This makes a very interesting "shadow" effect, but does require that you sand and polish each piece before fitting it.

Whatever project you choose, you'll end up with two big plusses. First, you will have some great gifts to give; second, you'll have a little more space to begin filling up all over again.

Please feel free to contact me by e-mail at quappell@ix.netcom.com.

Fossil Country USA

A complete Tyrannosaurs rex greets visitors to the Denver Museum of Natural History.

When In Denver Look Up Some Very Old Friends

by Steve Voynick

No one interested in fossils should miss the 32nd annual Denver Gem & Mineral Show in September 1999. This is called The Fossil Expo. More than two dozen top museums from the U.S., Canada and Europe will display some of their best specimens. And should these exhibits fire your paleontological imagination, you'll be in the best state in the nation to do something about it.

As the birthplace of modern dinosaur paleontology, Colorado offers visitors an array of superb paleontological museums and field sites. Six sites rank among the very best—the Denver Museum of Natural History, Dinosaur Ridge, the Canon City area, Florissant Fossil Beds National Monument, the Grand Junction area and the Douglas Pass fossil locality.

Which of these sites you choose to visit will depend on the time you have available. Some are just a 15-minute drive from the Denver Gem & Mineral Show; others, in western Colorado, are five hours away by car.

The fortunes of geology account for the abundance and richness of Colorado's paleontological resources. Midway through the Mesozoic era, some 200 million years ago, a subtropical climate fostered an explosion of diversity in plant and animal life. During the Jurassic and Cretaceous periods, dinosaurs thrived in lush forests near the shores of lakes and rivers that covered much of central and western Colorado. Eastern Colorado lay beneath a warm, shallow interior seaway teeming with marine life. This seaway deposited thick layers of shale, sandstone and limestone. As sea levels repetitively rose and fell, a broad shoreline of sandy beaches, bars and lagoons moved slowly back and forth across what is now modern Colorado.

The enormous number of fossils trapped in the deep sediments would have remained hidden forever had it not been for another bit of geological luck. As the dinosaurs neared extinction at the end of the Cretaceous Period, about 65 million years ago, enormous forces generated by colliding tectonic plates uplifted the Rocky Mountains (the north-south succession of ranges that now bisects Colorado). This uplift exposed many fossiliferous strata on both sides of the mountains. Even after the formation of the Rockies, alternating periods of localized deposition and subsequent erosion continued to produce and expose fossiliferous deposits, adding to Colorado's already remarkable fossil record.

The discovery of Colorado's first dinosaur fossils, more than a century ago, marked a major turning point in the advancement of paleontology. In 1877, local teacher Arthur Lakes searched for fossil leaves on a hogback ridge at Morrison, just 10 miles west of Denver. Instead of leaves, he found a 14-inch-thick fossilized femur and several huge vertebrae!

Lakes shipped a ton of these bones to Othniel Marsh at Yale's Peabody Museum. Receiving no response, Lakes sent a second shipment, this time to Marsh's bitter personal rival, Edward Drinker Cope. Only *then* did Marsh quickly pay Lakes $100 for the original shipment, thus "claiming" the Morrison fossil site. The spectacular results of Marsh's subsequent excavation excited both scientists and the public, triggering a Western "bone rush."

continued on page 22

From upper left, clockwise: An in-situ fossil vertebra from a Camasaurus on the interpretive trail at the Rabbit Valley Research Natural Area near Grand Junction; Florissant fossils are characterized by extraordinary detail, as in this fossilized fern-like plant; visitors at a dinosaur trackway at Dinosaur Ridge, near Morrison; this T-rex skull is in the paleontology lab at the Denver Museum of Natural History; (center) the fossil impression of a 35-million-year-old caterpillar in the shale of Florissant Fossil Beds National Monument.

Fossil Country/ *from page 21*

Old-World paleontologists had already proven the existence of dinosaurs, but the sporadic recovery of incomplete skeletons had excited neither scientists nor the public then the Morrison site yielded magnificent, complete skeletons of the sauropod *Diplodocus*, the carnosaur *Allosaurus* and the spined *Stegosaurus*.

In his controversial 1975 book, *The Hot-Blooded Dinosaurs*, A. J. Desmond stated the significance of the Morrison fossils. "Here, the monsters spring full formed from the earth," Desmond wrote. "It was as though a veil was dramatically lifted. ... No longer would paleontologists be forced to cope with crumbling fragmentary remains; from now on they were to unearth whole specimens, perfectly preserved in a veritable giant's graveyard."

Morrison was just the beginning of Colorado's adventure in fossils. Amateur "bone hunters" and paleontologists soon made other great discoveries, at Canon City, Florissant and in the Grand Junction area. Today, these sites are major points of paleontological interest.

If you go to admire the fossil exhibits at the 1999 Denver Gem & Mineral Show, consider taking in some of Colorado's other paleontological sites. There are six superb sites, and the place to start is the Denver Museum of Natural History, a 15-minute drive from the show.

Denver Museum of Natural History

In 1995, the Denver Museum of Natural History opened a paleontological exhibit called "Prehistoric Journey." Paleontologists needed six years and $7.7 million to build Prehistoric Journey, the largest and most ambitious special exhibit in the museum's 98-year history. Prehistoric Journey has since been acclaimed as one of the world's foremost paleontological exhibits.

Prehistoric Journey, which combines up-to-date paleontological knowledge and theory with exciting and dramatic new display concepts, features more than 500 superb fossil specimens, and focuses on the western interior paleo-region of the U.S. Paleontology, biology and geology come to life through touch specimens, videos, interactive computer displays, dioramas and reconstructions of actual North American fossil quarry sites. Most impressive are the unique, walk-through "paleo-enviroramas" that create an immersion experience by engaging visitors' senses of sight, smell, touch and hearing.

Prehistoric Journey is a permanent exhibit at the Denver Museum of Natural History, located at 2001 Colorado Boulevard, just east of downtown Denver. Entrance to Prehistoric Journey is included in the museum's general admission fee of $6 for adults and $4 for children ages 3-12 and seniors 60 and over. For tickets or information in the greater Denver area, call (303) 322-7009; from outside the Denver area, call (800) 925-2250. The museum is open from 9 a.m. to 5 p.m. Sunday through Wednesday, and from 9 a.m. to 7 p.m. Thursday through Saturday.

Dinosaur Ridge/Morrison

Just 10 miles west of Denver, this is the site of Arthur Lakes' 1877 discovery that opened the modern era of dinosaur paleontology. It's also a national natural landmark and the West's most easily accessible, major outdoor paleontological attraction.

In 1990, university researchers and volunteers turned Dinosaur Ridge into an outdoor museum where visitors can study in-situ dinosaur bones and tracks. The mile-long Dinosaur Ridge Trail has 16 interpretive stops at points of geological and paleontological interest.

The nearby Morrison Natural History Museum displays insect, plant and reptile fossils, along with fossilized dinosaur bones, tracks and eggs. Some of these dinosaur fossils are the original bones recovered during the historic 1877 excavations.

A nearby, 400-foot-high roadcut on I-70, at the Morrison Exit, exposes 20 million years of colorful geologic strata. Parking areas and paved walkways with interpretive signs are located on both sides of the interstate.

To reach Dinosaur Ridge from I-70, exit at the Morrison turnoff (Exit 259). Follow Colorado Route 93 south for 1.5 miles, to Alameda Parkway. Turn east on Alameda Parkway and follow the signs over Dinosaur Ridge, to the Visitors' Center. Monday-through-Saturday hours are 8 a.m. to 5 p.m., Sunday hours are 11 a.m. to 5 p.m. For more information about Dinosaur Ridge, call 303-697-DINO.

To reach the Morrison Natural History Museum, continue south on Colorado Route 93 for 2.0 miles and follow the signs. The museum is open Tuesday through Sunday from 11 a.m. to 5 p.m. Admission is $2 for adults and $4.50 for families. For additional information call 303-697-1873.

Canon City Area

The Garden Park dinosaur fossil localities, just north of Canon City, were identified in 1877, shortly after the Morrison discoveries. Paleontologists have recovered more specimens of giant sauropods, certain carnivores and the Jurassic *Stegosaurus* from Garden Park than from any other North American site.

The Garden Park Paleontology Society, in partnership with Canon City, the Bureau of Land Management and the Denver Museum of Natural History, has constructed the Dinosaur Depot Museum and prepared nearby paleontological field sites for visi-

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Fossil Country/ *from page 22*

tation. Dinosaur Depot, located in downtown Canon City, is an educational and interpretive facility. Exhibits include a dinosaur laboratory where a *Stegosaurus* skeleton, excavated 1992, is being prepared for display. Guides are available to explain exhibits and arrange tours into the nearby Garden Park fossil area.

Canon City, located 25 miles west of Pueblo, is just over a three-hour drive from Denver. For information about the Garden Park Paleontology Society, Dinosaur Depot and Garden Park fossil area sites, call (719) 269-7150 or (800) 987-6379

Florissant Fossil Beds National Monument

Florissant Fossil Beds National Monument—a three-hour drive from Denver, and located near the town of Florissant—is one of only three U.S. national parks or monuments devoted primarily to fossils. In number, quantity and variety, Florissant is North America's top fossil insect site.

The Florissant fossil deposit is a record of life in a 35-million-year-old Oligocene forest. Fossilization of plant life and insects began when nearby volcanic activity covered the area with mud flows and volcanic ash. Millions of years later, erosion uncovered the fossiliferous strata.

Paleoentomologists realized the significance of the site by 1880. By the 1930s, Florissant had yielded more than 80,000 museum-grade fossil specimens. To protect the site from commercial exploitation, Congress created Florissant Fossil Beds National Monument in 1969. The Visitors' Center displays fossil specimens and photographs.

Florissant is 35 miles west of Colorado Springs, on US 24. The entrance to Florissant Fossil Beds National Monument is located 3.0 miles south of Florissant, on Teller County Route 1. The monument is open year-round. Summer hours are from 8 a.m. to 6 p.m. For information, contact Florissant Fossil Beds National Monument, PO Box 185, Florissant, CO 80816.

Grand Junction Area

The Grand Junction area—about five hours west of Denver, on I-70—bills itself as "Dinosaur Country," and for good reason. In 1900, Elmer Riggs, assistant curator of paleontology at Chicago's Field Museum, began excavations near Grand Junction that uncovered skeletons of *Stegosaurus, Camarasaurus, Brachiosaurus* and *Allosaurus*.

The Dinosaur Valley Museum (the paleontology and natural history division of the Museum of Western Colorado, in downtown Grand Junction) features specimens from local fossil quarries, photographs and relics from pioneer paleontological expeditions, dinosaur trackways, a working paleontology lab and scaled-down, animated, robotic dinosaur models.

The museum provides directions to the interpretive trails at the nearby dinosaur quarries at Dinosaur Hill and Riggs Hill, as well as to the trail and quarry at the Rabbit Valley Research Natural Area, 30 miles west of Grand Junction.

Admission to the Dinosaur Valley Museum is $4 for adults and $2.50 for children. For information, contact the Dinosaur Valley Museum, 4th and Main Streets, Grand Junction, Colorado 81501, (970) 241-9210

The Devils Canyon Science and Learning Center is located in Fruita, 10 miles west of Grand Junction, on I-70. The center, headquarters of the Dinamation International Society, offers a blend of robotic and hands-on interactive exhibits, 14 scientifically accurate robotic dinosaurs and a working paleontological lab that prepares locally excavated fossils for study and display.

The center also schedules regular summer programs about paleontological excavation, under professional supervision. For more information, contact the Devils Canyon Science and Learning Center, 550 Jurassic Court, Fruita, CO 81521, (800) DIG-DINO.

Douglas Pass Fossil Locality

The Douglas Pass Eocene insect/plant fossil locality, in western Colorado, has produced many museum-grade specimens. The original organic matter of stems, leaves and insects was well carbonized during the fossilization process in the Green River Formation sediments. Accordingly, the dark-brown to nearly black fossil impressions contrast sharply against the light-grey shale, producing unusually attractive display specimens.

From Grand Junction, proceed 18 miles west on I-70 to Loma, then follow Colorado Route 139 north for 35 miles to the summit of 8,268-foot Douglas Pass. Follow the graded gravel road at the summit for 5.5 miles, to the prominent FAA radar station. The primary collecting area is in the roadcuts just below the station.

Although there are many other Colorado sites of interest to amateur paleontologists and fossil collectors, the six mentioned above simply should not be missed. Each is well worth the time it takes to visit. So, if the fossil exhibits of the 1999 Denver Gem and Mineral Show are bringing you to Colorado, take an extra day or two and visit a few of the nation's best paleontological sites. After all, Colorado isn't called "Fossil Country USA" for nothing.

Rock Science

by Steve Voynick

Hard Fossils, Soft Tissue

Not many years ago, fossilized, soft dinosaur tissue was considered extremely rare. Apart from occasional, fragmentary specimens of fossilized skin, paleontologists had identified so few specimens that they wrote them off as more of an oddity than as a resource for serious study. But recent, spectacular recoveries of remarkably detailed soft-tissue fossils are changing all that.

The most celebrated example is an early Cretaceous therapod fossil of a baby *Scipionyx samniticus* found a decade ago, in Italy, by an amateur paleontologist searching an area known for its well-preserved fossil fish. In early 1998, paleontologists re-examining the fossilized baby dinosaur were amazed to find details of soft anatomical structures that included large portions of the animal's intestines, colon, liver, muscles and windpipe. The liver of the *Scipionyx* fossil is even faintly tinted a dark purple from pigmentation that paleontologists believe may actually have survived after the animal's death.

"The animal's gut is also amazing," said Dr. Michael Benton, a British paleontologist who has studied the fossil. "You can clearly see its surface texture, which is lumpy and shiny, almost as you would see it after dissecting [the remains of] a modern animal. This animal's gut was shorter than ... expected, so it was probably able to process food very efficiently."

Although the lungs were not preserved, paleontologists believe that the position of the liver indicates the position of the lungs. This may indicate whether the dinosaur's breathing system was closer to that of modern-day crocodiles or birds, possibly shedding light on the controversy about whether birds did, indeed, evolve from dinosaurs.

Fossilization—even of hard teeth and bones—requires very precise conditions at the time of an animal's death. First, sediments must bury the remains very quickly. Second, they must be buried in a sedimentary medium capable of retarding decomposition. For fossilization of soft tissues to occur, these conditions are even more critical.

Fossilization of the Italian *Scipionyx* specimen must have occurred under textbook conditions. The animal lived in an area of shallow lagoons. Upon its death, unusually fine-grained marine sediments quickly covered the remains. Such fine-grained sediments produce "lithographic" limestones, so named because of their ability to preserve the smallest details.

Most importantly, the *Scipionyx's* sedimentary burial environment was apparently devoid of free oxygen. Rapid oxidation of other buried organic matter may have quickly consumed the available oxygen, leaving no oxygen to decompose the soft *Scipionyx* tissues. Mineralization (fossilization) therefore occurred before the soft tissues could decompose.

Just 20 years ago, three-dimensional examination of such a fossil would have been difficult, if not impossible. Paleontologists would have scraped away each layer to generally record tissue structure and shape until the rare fossil had been ultimately destroyed. Today, however, high technology, in the form of computerized axial tomography (CAT) scans, makes noninvasive, three-dimensional study possible.

Unusual mineral mediums also help to preserve soft dinosaur tissues. In 1997, Spanish paleontologists recovered a fossilized birdlike dinosaur, *Pelecaninimus polydon*, that included mineralized skin and muscle. The three-dimensional, fossilized muscle had been preserved in siderite (iron carbonate).

Some sections of the carcass were overgrown with microbial mats preserved in another mineral familiar to collectors: apatite (calcium phosphate). Paleontologists believe that phosphorus released by the slowly decomposing dinosaur became trapped and was deposited in sections of the microbial mat that directly contacted the carcass.

The resulting apatite shroud represents the outline of the dinosaur. It reveals a soft crest at the back of the head, as well as the distinctive throat pouch similar to that of a modern-day pelican, thus giving the *Pelecaninimus* its name.

Soft-tissue fossils are as not easy to spot as those of teeth and bones. By previously concentrating on "hard-part" fossils, paleontologists may have overlooked soft-tissue remains in the past. But that certainly won't be the case in the future.

As British paleontologist Derek Briggs writes, the recent soft tissue recoveries "... emphasize the need for careful monitoring of vertebrate remains for mineralized soft tissues before consigning them to the acid bath that releases the skeleton from its matrix."

THERE'S SOMETHING ABOUT A DINOSAUR

The Ongoing Fascination With Some Past Earthly Inhabitants

Bones believed to be of a hadrosaur, found in a bone bed approximately 150 feet up the side of a hill, in plaster jackets.

The author and his 12-year-old son, Andrew, coating a dinosaur bone (already covered with wet paper towels) with a burlap and plaster cast, to protect it before transport to the lab at the Dayton (Ohio) Museum of Natural History. Photo by Richard Terry, geology curator at the museum. All other photos by author.

by George Grossenbaugh

The fascination with dinosaurs has been with us for a very long time

Geologists tell us that the world is in a

draw informed conclusions regarding the Earth's climate and organisms during any given period.

This wealth of fossil evidence has become fodder for more than just the scientific community. It also impacts the world's social and economic situation. Fossil resources, new paleontological tools and techniques help to answer age-old questions regarding evolution and geology. And as other scientific disciplines have complemented as well as paleontology by amateurs and hobbyists, thanks to some find of monumental significance made by ordinary people.

continued on next page

Dinosaur/ *from page 29*

Recently, the Steven Spielberg movies *Jurassic Park* and *The Lost World* excited millions of people and helped to orchestrate a new wave of "dinomania." The interest in both dinosaurs and the hunt for their fossil remains is phenomenal. The discoveries of new dinosaur species and the fossil remains of dinosaurs and other large predatory creatures continue to fuel the interest of the general public.

Growing up in Ohio, I was not able to hunt for dinosaurs. The local fossil trail includes mostly marine invertebrate animals, plants and some fish. All of these fossils are fairly small. Every so often someone finds a large land animal that roamed this area during the Pleistocene Age, but these finds are very infrequent. So, can you imagine my excitement at the possibility of going on a dinosaur dig and being able to work in the field side by side with paleontologists, hunting for dinosaurs?

My son and I were fortunate to be part of a group traveling to the Alberta, Canada, Badlands on behalf of the Dayton (Ohio) Museum of Natural History. The purpose of the trip was to find a dinosaur specimen, prepare it in the field, and then help prepare it again, in the lab, for display at the museum. This endeavor was rewarding to this "old fossil hunter" but, more importantly, provided my 12-year-old son with a fantastic educational experience in a field of science that he really loves.

Alberta has a wealth of mineral, coal and gas deposits. It is this geological abundance that helped the world become aware of the wealth of dinosaur fossils waiting to be found in this region.

In 1884, the Canadian government sent a geologist, Joseph Tyrrell, to locate and map the area for new deposits of minerals and coal. It was during his time in Red Deer River Canyon, in central Alberta, that he discovered the partial skull of a carnivorous dinosaur, which would later become known as *Albertosaurus sarcophagus*

The Canadian Geological Survey sent other parties to this region following Tyrrell's discovery. However, it was not until 1909 that the area experienced an influx of dinosaur hunters from all over North America. The great dinosaur hunters Barnum Brown and Charles H. Sternberg went there in search of specimens and, thus, set off the "great dinosaur rush" in Alberta.

Our present-day adventure started as we set out from Calgary to Drumheller, Alberta. Drumheller is located about 138 km from Calgary. Along the way, we made a stop at Horseshoe Canyon, where we got our first look at the Badlands. They have a very stark beauty, appearing on the surface in a fertile area, then dropping off into deep, cavernous sections of different-colored strata

The Badlands were formed some 12,000 years ago, when sheets of ice from retreating glaciers carved the land, leaving steep canyons and gullies in the landscape. Erosion also played a factor in the Badlands, as the land was eroded away and different layers of rock became exposed.

The multicolored strata reveal layers of mudstone, sandstone and coal. While visiting Horseshoe Canyon, we were able to see a bronze/red layer of sediment. This represents the iridium layer, believed to mark the end of the dinosaur era.

As we traveled down into the Red Deer River Valley, we were greeted by a large T-rex statue standing guard at the outskirts of Drumheller.

The weather during this late June trip was very comfortable, except for rain the first two days we were in town. The rain created a small problem, making the hike to the site quite torturous. The Badlands locality was approximately 3 km into the canyon. The area is covered with a clay-rich soil that turns to a slippery petroleum-jelly type substance when wet. It is very dangerous for anyone to walk on when trying to negotiate the steep hills and valleys of the Badlands.

On the third day the weather improved, and we were able to start our 30-minute trek to the site. High on the top of a hill was the site where, during the previous week, another group from the Dayton Museum had started the excavation. The site had already been scouted and some very promising bones had been located near the surface.

The matrix at the dig site was a type of mudstone with small, interbedded coal layers and a thicker, ironstone layer. The mudstone was a very easy matrix to remove. All that was needed was a screwdriver or wide-bladed knife. By digging into the mudstone with a gentle touch, the mudstone would come off in layers. We put the debris in five-gallon buckets and dumped them on the side of the hill

The site we worked turned out to be a fairly large bone bed In the short time this site was worked, 44 bones were uncovered. It appeared we had reached a bone bed of many different, disarticulated animals.

The Badlands dig site dated the rock from the Late Cretaceous, of Maastrichtian age, in the Horseshoe Canyon formation—some 68 million years old The sedimentary layers we had been digging in were from a time when the Badlands were actually river floodplains and deltas that supported the large dinosaur population of the time

These conditions helped to preserve the large number of dinosaur remains found in Drumheller. When the dinosaurs

continued on next page

Dinosaur/ *from page 31*

were dead, the waters took the bones to a point near the delta, where they were then covered with sediment. This trip usually caused the skeletal remains to become disarticulated.

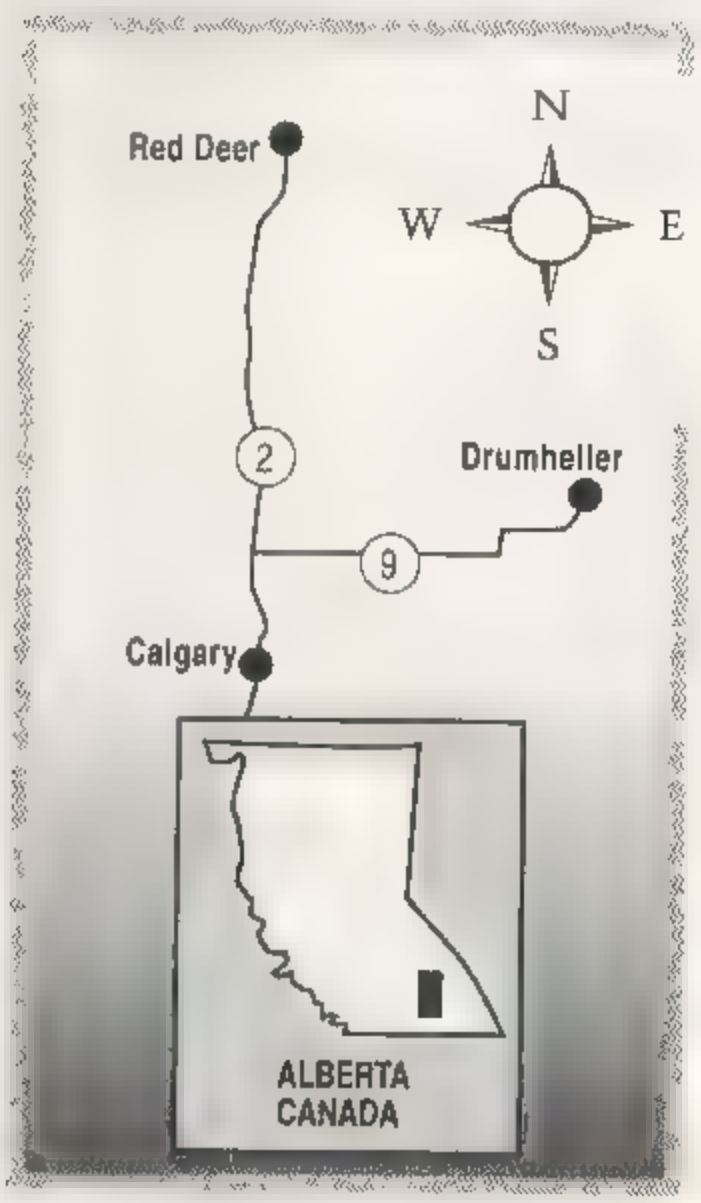
It is very difficult to find a fully articulated dinosaur. The bones we found may have been from a number of different individual animals. Our finding of four large, 4- to 4.5-foot femurs seemed to support this idea.

At the start of our dig, it was very difficult to determine what was bone and what was not. The grey mudstone was easily distinguishable but, as we dug further into the sediment, we would come across coal layers and ironstone layers. The dark-bronze ironstone layers could be easily confused with bone. When we reached an area of this texture of material, we had to move very cautiously so no damage would be done to the brittle bone—if we had, in fact, uncovered a bone.

While digging, it was not unusual to hit a coal seam in the sediment. This seam always contained small, teardrop-sized pieces of amber. We had to be very careful with the amber because it would break up under the slightest bit of pressure.

It was also not uncommon to uncover pieces of wood that had been buried in the sediment. At first, this was confusing to the novice digger because it appeared to be bone.

One key to finding bone in the mudstone was to look for a whitish-grey moss that seemed to be covering parts of the bone. If we got to a layer that contained the moss, we were almost always rewarded with the finding of another bone.



Once a portion of the bone was uncovered, it was imperative to cover the bone with a preservative. The preservative we used was nicknamed "butter." It was a mixture of a polymer resin and acetone. This would serve to protect and strengthen the bone as the air met it for the first time in millions of years. As more and more of the bone was unearthed, continual recoating of the exposed surface was needed.

Once the top portion of the bone was uncovered, the sides were dug out to form a pedestal upon which the bone would sit. The bone would then be covered with wet paper towels. This would act as a separator before the plaster was applied. Burlap soaked in a watery plaster liquid was then applied to strengthen the bone package before its removal from the ground. When the plaster was dry, the "bone pedestal" was then flipped over so the same process could be repeated to the underside. After all the plaster was dry, the bone was numbered and could be removed to the transport site.

The two-week dig uncovered about 21 bones. Each bone was wrapped in its plaster cast and placed in an area to protect it from the elements. Some bones that could not be unearthed within this time frame were prepared and buried, awaiting our return next year. A detailed grid map was completed that listed each bone that had been removed, as well as the bones which were located but not removed. The grid map would also show the position in which the bone was facing before it was uncovered.

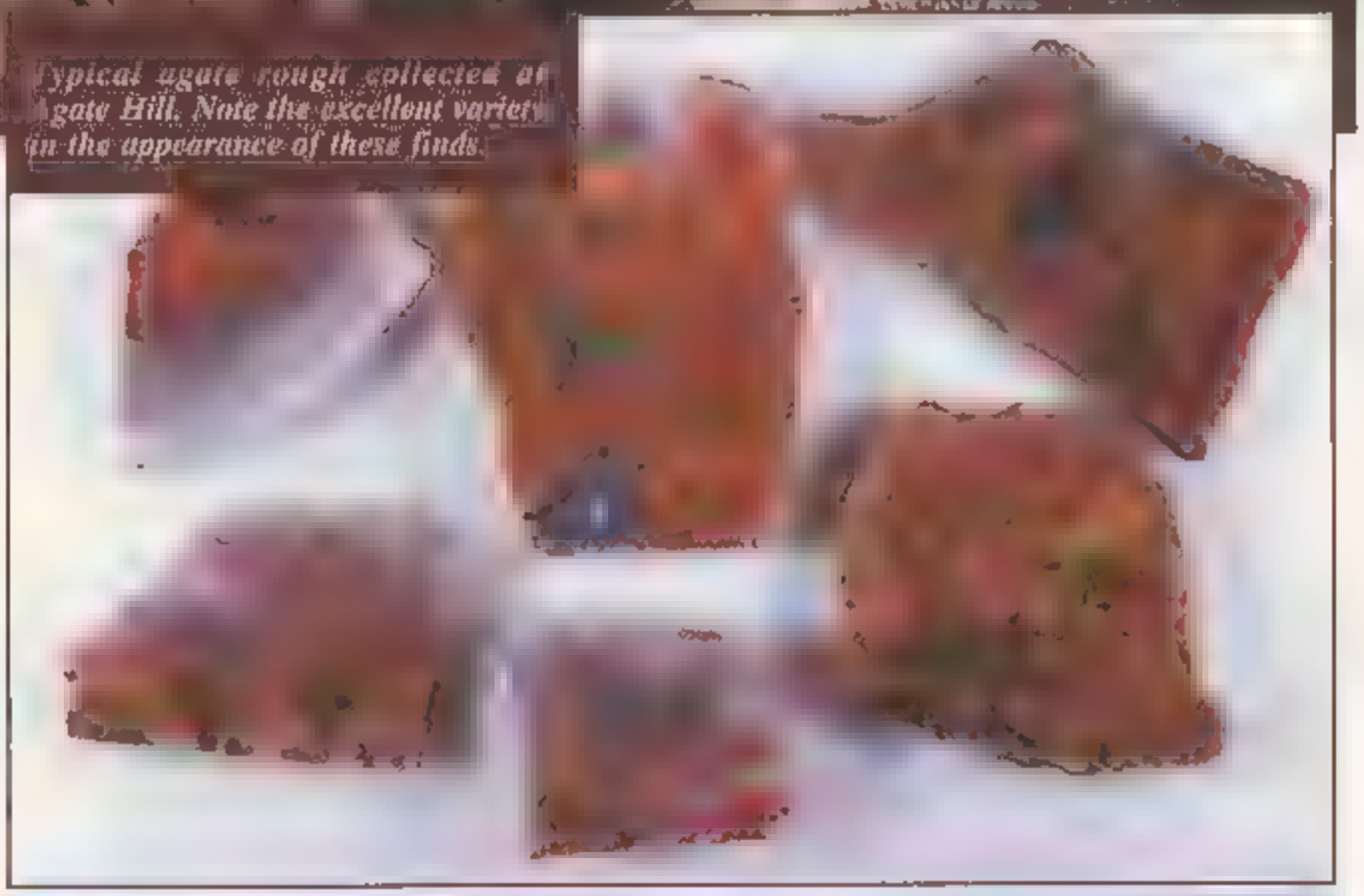
Some of the more interesting finds during our visit were fossilized tendons and teeth located at the dig site. The bones we uncovered appeared to be from a hadrosaur (duck-billed dinosaur). A total of four femurs were located which indicated more than one animal was present at this locality. Also found at this location were five theropod teeth. These teeth were interesting because they conjured visions of a carnivorous theropod busy having a hadrosaur for dinner.

Our trip to Drumheller would not have been complete without a visit to the Royal Tyrrell Museum of Paleontology. This museum is one of the most spectacular dinosaur museums in the world. It covers over 34,000 square feet and has more than 30 complete dinosaur skeletons on display. A large window allows you to watch the fossil preparation in the laboratory, located within the dinosaur display area. The Royal Tyrrell Museum also has live demonstrations where fossils are prepared and questions can be asked of the preparer.

This was truly a fantastic trip. The Royal Tyrrell Museum offers tours and "day digs" through the museum in Dinosaur Provisional Park. Trips can also be arranged with Exposaur Excursions in Drumheller or with the Dayton Museum of Natural History.

Agate seams at the Agate Hill locality. The rock hammer is included to give the reader an idea of the size of these seams.

Typical agate rough collected at Agate Hill. Note the excellent variety in the appearance of these finds.



The author [illegible] Hill, intent on studying something she has found right on the surface. Photos by author.

by William A. Kappele

Our trip to Agate Hill and Obsidian Hill begins in Delta, a city perched at an altitude of 4,755 feet, on the edge of the "great west desert" of Utah. The 3,000-or-so citizens enjoy average yearly high temperatures of 66.5 degrees and lows of 38.4 degrees. If you work around the coldest of the winter months or the hottest of the summertime, you can get in some really pleasant rockhounding

Because of the low humidity, my wife and I have done a lot of hunting when the temperature was well over 100 degrees without major discomfort. Cold is another thing. You are on your own then. Remember, rocks just don't look the same with six inches of snow on them

Delta may seem to be an unlikely place for farming. But it must have seemed even more so to those who passed it by in the early 1800s. Around the turn of the century, though, a group of farmers had the idea that there was sufficient water underground (but near enough to the surface) to allow alfalfa to grow with "subirrigation" ... *if* enough water could be provided at the surface to get the plants started

In the summer of 1903, they gathered up some drilling equipment and headed to a site about five miles southeast of what is now Delta. Unfortunately, they discovered that the water was about 10 feet from the surface—too deep for subirrigation. So the land remained desert for a number of years, during which a drought parched it even more.

continued on next page

Trilobites/ *from page 41*

There was a good flow in the Sevier River in the winter and spring, though. And eventually the Deseret Irrigation Company filed on the surplus waters of the river and began to construct a dam to hold it. Not long afterward the team realized that more had been bitten off than could be chewed, and the company began to look for help with the financing and construction.

A group from the Millard Stake of the Mormon Church looked over the projected dam and the surrounding land. They thought it held promise. Consequently, they sent James A. Mellville to make sure that the legal aspects of the water rights were in order. They were, so the Mellville Irrigation Company was formed for the purpose of building reservoirs and canals. A town, also called Mellville, was laid out, and by 1910, the local boarding school taught children from 13 states, Canada, Mexico and Samoa.

In 1908, the community was just a dreary, greasewood flat. There were two wells, and all of the drinking water had to be hauled from one or the other. Greasewood roots were used for firewood, since wood itself was an almost nonexistent commodity there.

Also in 1908, a gentleman by the name of McCullough built a small addition onto his house, to be used as a post office. Unfortunately, post office officials thought Mellville was too close in spelling to an established post office at Mellville. The remedy was to change the name of the town of Mellville to Burtner, after a local railroad passenger agent. This time, the railroad balked and refused to grant a station to a town named Burtner. (Picky-picky!)

To settle all of this, the *Millard County Chronicle Progress* ran a contest to name the town. John Steele submitted the name Delta, and the rest is history.

Almost all rockhounds who come to the Delta area spend at least part of their trip at Antelope Springs, splitting shale in search of trilobites. If you are new to the hobby or just don't know much about fossils, trilobites are an extinct member of the phylum *Arthropoda*, which means that they had jointed bodies and exoskeletons. (Doesn't a skeleton on the outside sound like a government project?)

Current arthropods include such friendly fellows as spiders, ticks, crabs, lobsters, barnacles, centipedes and other such things you don't want to find in your sleeping bag. Don't worry about finding a living trilobite, though. They've been extinct for something like 200 million years.

They were around for a long time before they met their ultimate fate. For about 300 million years, trilobites crawled around on the floors of all of the oceans of the world, munching happily on soft food. (Their mandibles were not up to snuff.) They ranged in size from approximately an eighth of an inch to over two feet. I don't know about you, but I'm sort of glad that those two-footers are gone

One nice thing about having an exoskeleton is that the fossil looks exactly like the animal looked in life because the soft tissue was all inside. Imagine what it would be like if dinosaurs had had such skeletons. We would know, without guessing, precisely which had scales, crests, feathers, etc.

If you are considering a trip to Delta, you can go out U.S. 50/6 and follow the signs along the dirt roads, but I strongly suggest that you first visit one of the several rock shops in town and get full information on where to go and how to collect. The shopkeepers are very accommodating, and will save you a lot of time and effort. You can even sign up for a guided tour, if you wish.

This time I'll take you to the primary destination in the other direction. Start at the intersection of U.S. 50/6 at the east end of town. Go northeast on U.S. 6, toward Eureka, for 10.3 miles, to the junction with Utah Highway 174. This is known locally as the Brush-Wellman Road. Go west on 174 for 35.2 miles, to a dirt road going left. There are *three* roads going left along here. My advice, so that you don't become confused by my directions, is to ignore the first two roads you come to when you approach the mileage. Take the third and drive about 1.3 miles. At this point, you should see a small, black lava flow just ahead on the left. Right before you reach the flow, there is a faint dirt track going right to Agate Hill. The track runs about 0.3 of a mile to a nice wide place to park.

If you are a dyed-in-the-wool four-wheeler, you can drive up the hill, but it is pretty rough and you will *miss some nice agate* on the way. Hunt all over the hill for a wide range of colors and patterns. You will find everything from chips to big seams that require heavy-duty hammers and gads.

From the top of the hill, you will see a similar hill to the west. We didn't go over there, but it looks like a promising spot. There is also a little agate behind the little lava flow, across the road from where you will come in.

When you have loaded up on all of the agate you can carry, go back to Utah 174 and head west (left). In a little over 2.0 miles, you will see the road to Topaz Mountain going right. This is the second place most rockhounds head to in the Delta area. The mountain has been a prime collecting area since John Quincy Adams was president. This idea is reinforced by those who feel that collecting on Topaz Mountain is not over and the best is yet to come.

Whether the best is still waiting for us or not, there is a lot of beautiful gem-quality

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Trilobites/ *from page 42*

topaz taken home from there each year. You won't step out of your pickup and stumble over a five-pound gemstone or anything like that. But if you are willing to work, you stand a chance of having success.

The best way to find your treasure is to climb around looking for fissures, soft spots, cracks, vegetation, etc. When you find one, use a screwdriver, thin chisel or some other similar device to widen the crack or dig out the soft stuff. This topaz bleaches out to clear in a short time in the sun, so digging is the only way to get the prize material. If you find a nice sherry-colored gem that is too heavy to lift, give me a call and I'll drive out and help you load it.

When you get back to the Utah 174 again, turn right and drive about 6.2 miles west, to the end of the pavement. At this point, the road forks. Take the right "tine" 0.2 of a mile to a dirt track going right. Follow the track for 0.1 of a mile and park.

The low rise ahead of you is Obsidian Hill. When you start walking around on it, you'll realize how it got its name. There must have been a lot of very sad Apaches out there, because the ground is covered with their tears.

If you return to the fork and head back toward Delta for 0.1 of a mile, to your right you will see some diggings on a low hill. If you have a pickup or four-wheel-drive vehicle, take the faint track over there. On the other hand, it is only about another 0.1 of a mile, so it is easy to just park off the road and walk over there.

What this looks like to me is that someone was after gravel and dug this fair-sized pit. There is gravel there, but much of it is made up of little tan and brown jasper pebbles that look like they just came out of the tumbler. There are also some little pieces of nicely figured agate. Perhaps this was an ancient riverbed, because the stones sure look like river gravel to me.

By the way, we stumbled on this site by accident, so we got to name it. The little pebbles looked like those butterscotch chips in the cookies I used to be able to eat when I still had a waistline, so we called it Butterscotch Hill. Come to think of it, we should have called it Butterscotch Pit.

You may notice the sign to Fish Springs National Wildlife Refuge at the fork. When we first saw the sign, it was just like seeing a sign reading "To the sand dunes" in the middle of Manhattan. As it turns out, just 20 miles or so from the fork in this arid desert spot, is a 10,000-acre marsh fed by five major springs and a number of lesser ones. The refuge encompasses a total of 17,992 acres between two small mountain ranges. Over 250 species of birds have been spotted at the refuge. The waterfowl include swans, Canada geese, mallards, green-winged teal, cinnamon teal, pintails, widgeons, gadwalls, redheads, canvasbacks, buffleheads, goldeneyes, ruddy ducks and mergansers. Some of the shore and wading birds include great blue herons, snowy egrets, black-crowned night herons, white-faced ibises, avocets, black-necked stilts and eared grebes.

The best seasons for observing the birds are late fall and early spring. These are probably the best times for rockhounding, too.

Fish Springs Refuge is a true oasis. Its huge marsh sits smack in the middle of the Great Basin Desert. At one time, though, the area that is now marsh was an 850-foot deep spot in the 20,000-square-mile Lake Bonneville. (It must have taken all day to row a rubber raft across that!)

In more modern times, the springs at the marsh were used by pre-Columbian Indians and then by some of the early explorers. Jedediah Smith visited the area on his way from California to Utah. The Overland Stage and Pony Express had stations at Fish Springs, and the wires of the first transcontinental telegraph crossed the marsh. Finally, the first transcontinental roadway, Lincoln Highway, passed through part of what is now the refuge.

Parts of the old highway are still visible. Can a freeway be far behind? Actually, you might wish for one as you bump along the gravel.

Fish Springs is 104 miles southwest of Tooele and 78 miles northwest of Delta. It is 42 miles to the nearest gas station, and all of this travel is across uninhabited desert. And there are no "Golden Arches" in sight. So, if you make the trip, be sure you have a full tank of gas when you start. Take plenty of water and some kind of emergency communications device—a ham radio or cell phone (though it may not work way out there). Be sure and let someone know where you are going and when you should be back.

When you get to the refuge, you can take the 11-mile, self-guided driving tour, use the picnic grounds and get a nice long drink of water at the refuge headquarters. If you would like more information, contact the refuge manager at Fish Springs National Wildlife Refuge, Dugway, UT 84022, or call (801) 831-5353.

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MYSTICAL WEAPONS OF THE ANASAZI

Since Anasazi artifacts can no longer be collected by anyone except accredited archaeologists, Hudson decided to try to duplicate them. With this one he did a particularly spectacular job, since this actually outshines most originals.

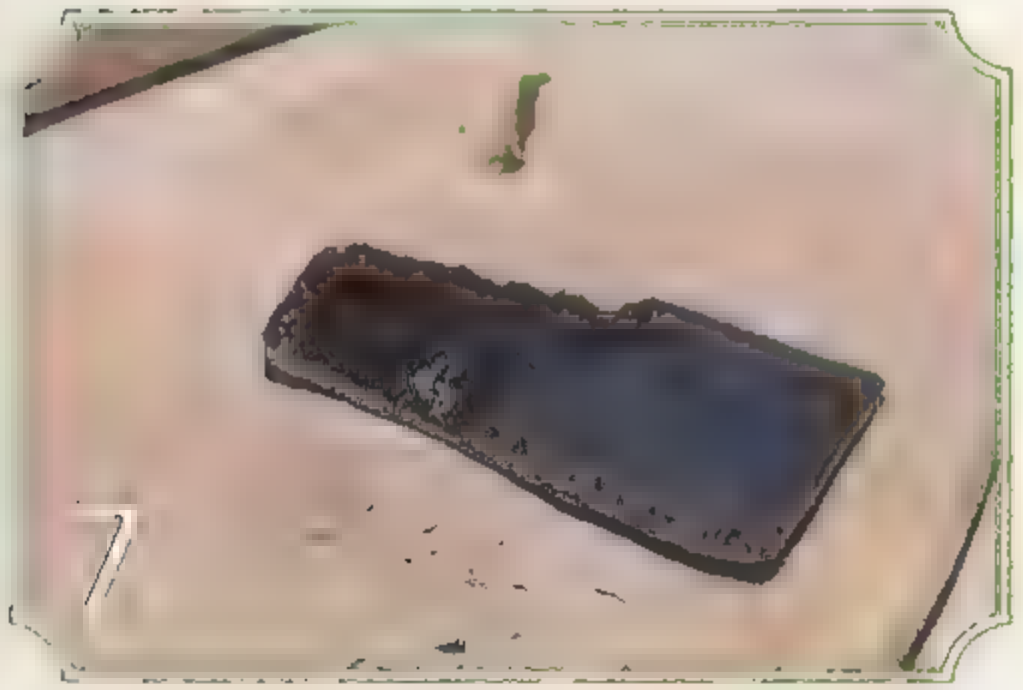
This shot is a good indication of Hudson's attention to fine detail.

One of the author's first steps is to cut a slab of the right thickness from a block of obsidian or jasper.

Notice the heavy-duty leather gloves the author is wearing here. An Anasazi axe blade sliced right through one of these with ease!

Hudson begins shaping at the back edge of the piece he is fashioning.

Only after it is nearly finished does he work on creating the arrowhead's tip.



This is what a typical slab looks like after he has extracted enough material to make one of his Anasazi-type creations.

Notice the extra protection of two layers of leather he uses when knapping a sharp edge. This way his gloves (and hands) remain intact.

(Hudson fabricated or modified many of the tools he uses. This is a representative sampling.

A Modern Craftsman Perpetuates A True American Heritage

by Carl Kuntze

The Anasazis had a relatively sophisticated civilization, as evidenced by the architectural ruins and artifacts they left behind. But they were apparently unacquainted with metallurgy. Blades on their weapons were ground from polished stone. They gathered volcanic rocks like obsidian and jasper, honing them into fine edges for knives, spearpoints, tomahawks and axes.

Despite their choice of material, the results these enigmatic Indian tribes, that once inhabited the mountainous regions of Arizona, Colorado, New Mexico and southern Utah, achieved were hardly primitive. Each piece reveals a considerable investment of imagination, skills in form, function and decoration. These enigmatic Indian tribes once inhabited the mountainous regions of Arizona, Colorado, New Mexico and southern Utah.

continued on next page

This is part of a collection of Anasazi arrowheads and other weapons and tools. Their beauty of form and practicality of function, coming from such an ancient people, are awe-inspiring

Weapons/ *from page 49*

Sixty-six-year-old, semiretired optical engineer Eugene J. Hudson encountered Anasazi arrowheads about 25 years ago on his treks across this ancient people's hunting grounds in Utah

Hudson admits that history was far from his mind when he started collecting them. He began his collection, he says, "... because I found them strikingly beautiful."

He started reproducing stone weapons of his own when the Bureau of Land Management and the local Department of Parks proscribed harvesting Native American relics. Many of them were scattered over sacred burial sites, and vocal protests were reverberating, not only from tribal leaders, but from sympathetic scholars as well.

Federal and state legislation was passed more to protect antiquities than to appease offended Indian sensibilities. In other words, it was deemed less desirable to have irreplaceable specimens removed from public sites, to be sold and then secreted among private acquisitions, away from general view. Today, only archaeologists accredited by museums and universities are allowed to excavate and extract fragmentary remnants of these ancient inhabitants of our continent.

Hudson is unabashedly awed by the craftsmanship visible in Indian stone weapons. They are not only alluring to the eye, but lethal as well. With the smooth slice of a razor, an axe blade he once handled penetrated the thick protective leather glove he wore.

While he visited out-of-the-way museums on his rock-hunting forays, one particular institution impressed him deeply: the Los Toros Museum, in northern California. "They have the most comprehensive collection of Indian memorabilia I ever saw," Hudson marvels

The exhibits and brochures he found there provided the inspiration for many of his designs, which approach, and sometimes exceed, the quality of Anasazi originals. This is probably due to modern tools available to him, many of which he fabricated and/or modified himself

It was the U.S. Army that discovered Hudson's aptitude for delicate work. Serving as a corporal with the 723rd Armored Division, at Camp Irwin, California, from 1953 to 1955, he maintained and recalibrated rangefinders on tank cannons.

"I was drafted at the tail end of [the] hostilities during the Korean War," he explains modestly, "which offered me the opportunity to develop my skills."

Hudson's interest in optics persisted after he left the Service. Enrolling in a technical institute in Ogden, he earned a certificate in electrical engineering, but got sidetracked by his affinity for optical gear.

A job repairing medical and laboratory equipment at Logan Regional Hospital encouraged him to start his own business. Forced to suspend his lapidary activities, he serviced medical facilities in the region for 30 years, only engaging in his hobby during his spare time.

Upon retiring, Hudson soon concentrated on his first love. While he still gets service calls from loyal customers, he found himself idle most of the time. "I was bored. It's a good thing I have my stones to fall back on," he muses.

He prospected for rocks in Oregon, northern California, Idaho and southern Utah, together with his wife, who shares his obsession. Although he looks remarkably fit and seems much younger than his actual age, he concedes having had to curtail long expeditions.

At present, Hudson has sufficient raw material to work.

Like many highly skilled artisans, he's reluctant to dispose of his finished projects. They're too much an inseparable part of him. Proud enough to display them, he's aware that, as his carvings continue to accumulate, he'd be taxing the storage capacity of his spacious home in Wellsville. Sooner or later, he'll have to sell selected pieces in order to be able to fashion new ones. But he plans to retain finer pieces and bequeath them to a museum upon his death.

In his own way, Hudson is perpetuating Indian culture, an integral part of our American heritage.

The author showing Jenifer and Jessica Culter how to spit open the sandstone layers.

Searching The Remnants Of An Ancient Seabed In Oregon

by Lita R. Smith-Gharet

A prehistoric record lies just under the I-5 corridor of the Willamette Valley in western Oregon. Geologists have discovered evidence of this as far south as Eugene and as far north as Portland. It consists of a rust-colored ash clay, and is the remnants of an Oligocene seabed

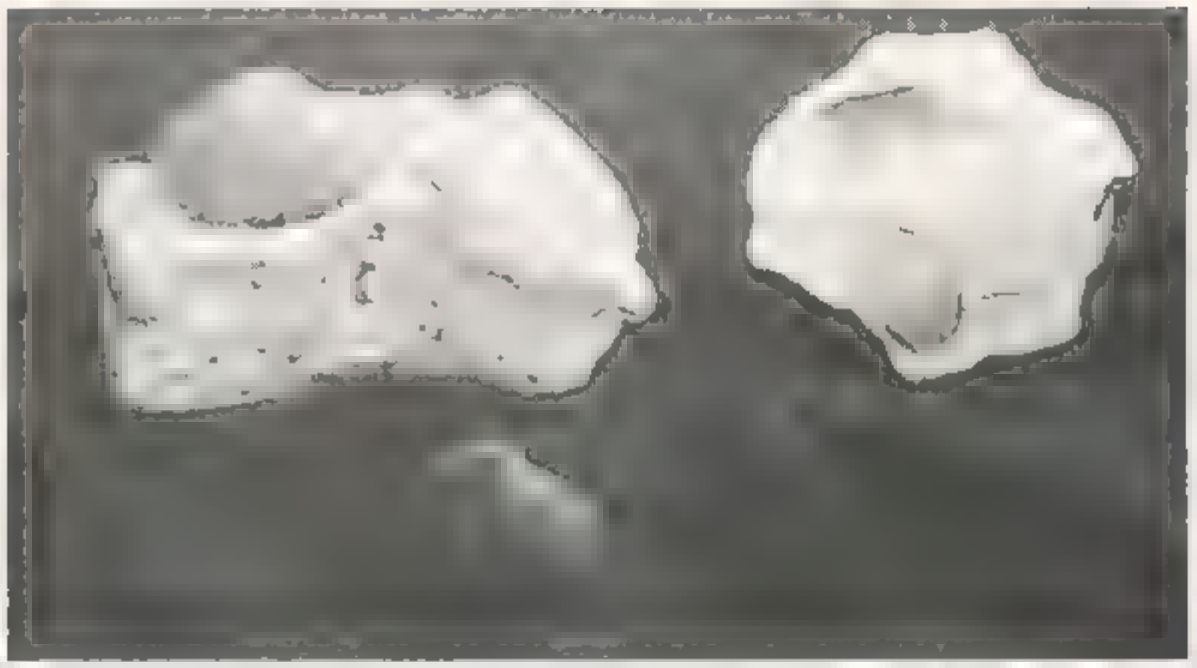
The shallow waters (30-40 fathoms deep) represented a much warmer climate—subtropical to temperate—and the sea life that was laid down before the Coast Mountain Range began its uplift, dividing Salem from Oregon's now-scenic coastline

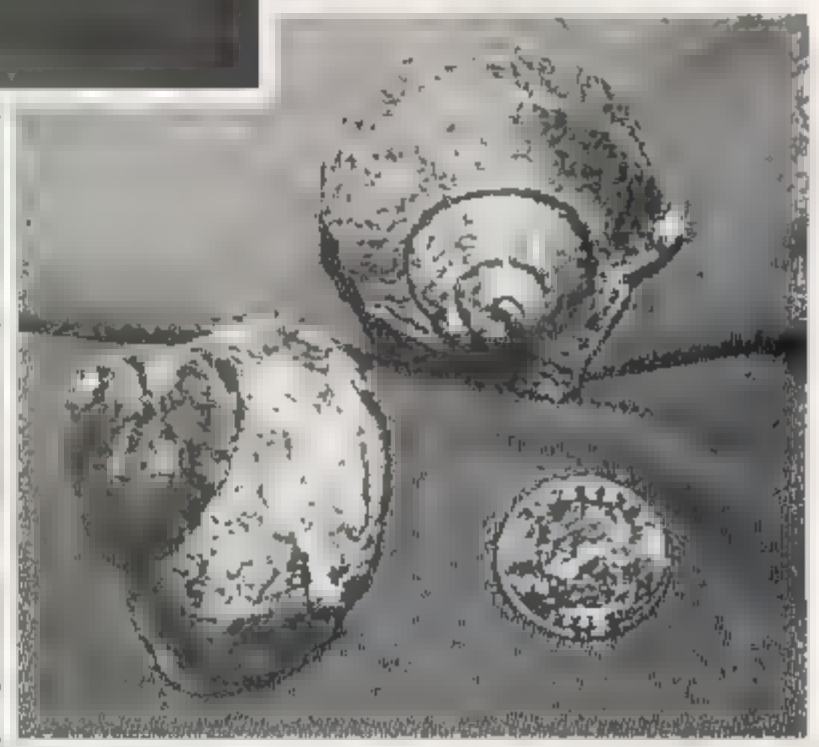
There was little if any ocean lapping and no shifting, uneven sands. It must have been a great place to be if you were a clam. Well, not exactly. There were a few offshore volcanic vents spewing out pillow lava from time to time. Even larger vents were puffing out layers of tuffaceous ash that precipitated down through the seawater, settling in layers on the seafloor. This action suffocated and solidified the small bi-valves and gastropods where they lay

This region is known as the Eugene Formation. Here you can see fossils in exposed locations and explore millions of years into the past. We are now able to extract the sandy ash blocks from a railroad cut and pop them with a screwdriver and hammer, to expose the rust-colored molds and sand casts of these preserved ancient organisms for our collections

As you collect at this location, keep in mind that, as abundant and shapely as these fossils are, they are just as fragile and unstable. There is little, if any, true calcified—and no silica—shell replacement on the surfaces of these fossil remains. These shells are merely molds in a fairly coarse silty sand replacement that is the same consistency in both the shell and its matrix.

These particular fossils are usually best displayed as cabinet display pieces, with the imprints left on the sandstone rock. Occasionally, however, individual molds





From far left, clockwise: Trewr Brown and the Culter girls collecting from the ledge; Spisula and Acila specimens (both are types of pelecypods); Olequahia schencki, a gastropod (note the quarter in the shot, which indicates the relative size of these Oligocene fossils).

will separate from the stone. These need to be wrapped carefully and placed away from heavier specimens

Directions To The Collecting Localities

From Interstate 5 at Salem, take the Highway 22 exit (numbered 253) west into Salem. (You may wish to stop at a gas station and purchase a Salem road map.)

As you continue toward town, you will notice that the road you are on is now called Mission Street. Stay on Mission Street until it splits. Turn south (left). Now look for Owens Road. Turn right (west) and start tracking your mileage here

As you travel down this road the name changes again to River Road. This is the old road to the small town of Independence Continue on this winding farm road until you come to a Y in the road. There is a combination restaurant/store on your right. Now you are in the very small town of Roberts At the flashing light stay to the right. You will shortly cross a set of railroad tracks, and will notice another Y in the road. Stay to the left. Do *not* go up the hill. Travel approximately 3.0 miles. Continue on River Road until you see another road on your left, just under a railroad viaduct. This is Riverdale Road, and it will meet with River Road on your left at 0.9 miles. Do not go under the viaduct. There, at the south end, along the highway, is a wide gravel spot on your left. Park on the gravel

From Highway 99 as you enter the town of Monmouth from the north or south, look for the traffic light turn. There, turn east on Highway 51, toward the town of Independence. Go about 2.0 miles, to the historic section of town. Independence is said to be the true end of the Oregon Trail, which started in Independence, Missouri, and ended in the fertile valley of Independence, Oregon

When you get to the T in the road and the flashing three-way stoplight, turn right (south). Do not stay on Hwy 51, which turns north here. Travel approximately 7 blocks to "I" Street. Turn left and start keeping track of your mileage now. You will immediately travel over a half-mile-long bridge and eventually wind around and under two 15-mph railroad viaducts and corners. When you have driven about 5.2 miles, you will see a gravel pull off on your right just before Riverdale Road pops out from under a viaduct, also on the right. Park here. If you come to a three-way stop in Roberts, you have gone too far.

Location Information

At the parking area you will see a gravel path leading perhaps 12 to 15 feet up to the railroad tracks. Proceed up this trail and turn right. Walk about 75 yards (150 wooden ties), until you reach a small ravine where the walls are about 30 feet high on both sides of the railroad tracks. This is the place!

Many times there are four- to six-pound chunks, or blocks, of sandstone down in the ditch. These can be popped open on the seams to reveal clam molds. This is a good place to start, as it will help you get the concept of what you're seeking

Next, you will probably want to scamper up the face to pull out newer and larger, pieces. If you study the face of the ravine, you will quickly get an idea of where you'll want to start digging.

Once you have removed several pieces of sandstone, rotate them. This will give you an idea of the bedding plains or faint layering. Many times, the darker lines indicate the layers. Place your screwdriver

continued on next page

Oligocene/ *from page 69*

or thin chisel on one of these zones and tap with your rock hammer in several spots around the stone, but all in the same layer. The heavy steel railroad track works great as an anvil, but be sure to remove all debris from the track area when you're finished. This area is well-used by school field-trippers and Scout groups. If the railroad folks have to keep clearing it, they *will* close it to collectors.

Although I have never encountered a train in this small canyon, that doesn't mean one won't come chugging through at any time. So, please keep close track of small children and pets

On one occasion, I was busy stuffing my five-gallon bucket with newly acquired goodies, when a small vehicle went by on on the tracks at about 10 mph, spraying weedkiller in a swath four to five feet wide on both sides of the tracks, up to the cliff walls. Not wishing to breathe poisonous herbicide fumes, and now having wet, toxic muck on my skin, I hastened back to my truck and drove home to a nice hot shower. So be aware that this same unpleasant thing could happen to you.

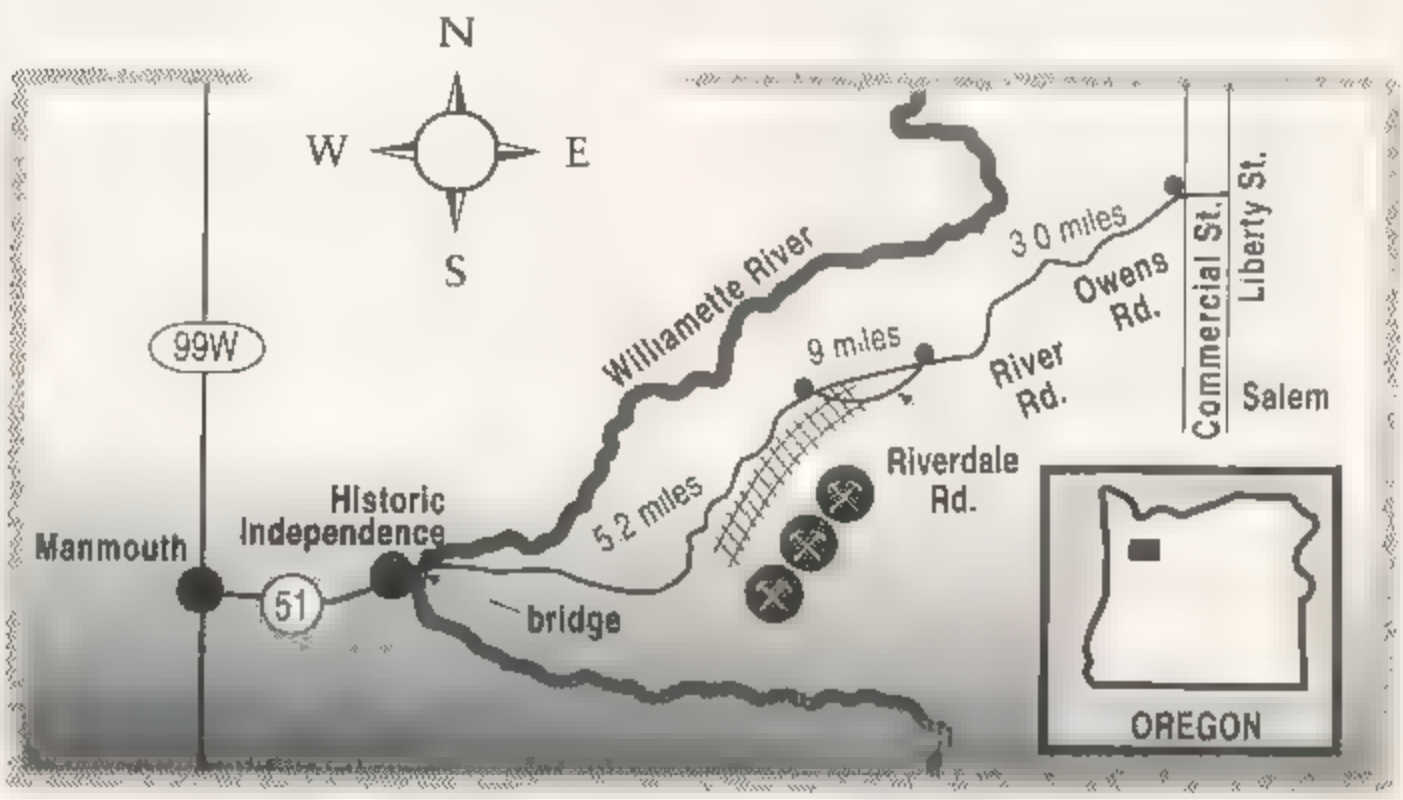
After you have collected everything your heart desires, lay your treasures out on a flat surface and check them for quality. If you have both the positive and negative sides, and wish to keep both, carefully put them back together and wrap them tightly in newspaper. Keep them protected this way until you get them home. It is a good idea to try to keep as much of the host rock intact as possible, in order to protect your fossils. Once you are home again, and your finds have dried for a day or two, use small tools or dental picks to clean them properly. Then seal them with spray lacquer.

The Eugene Formation is home to 67 species of fossil sea life, and most of these are not represented at the Salem location.

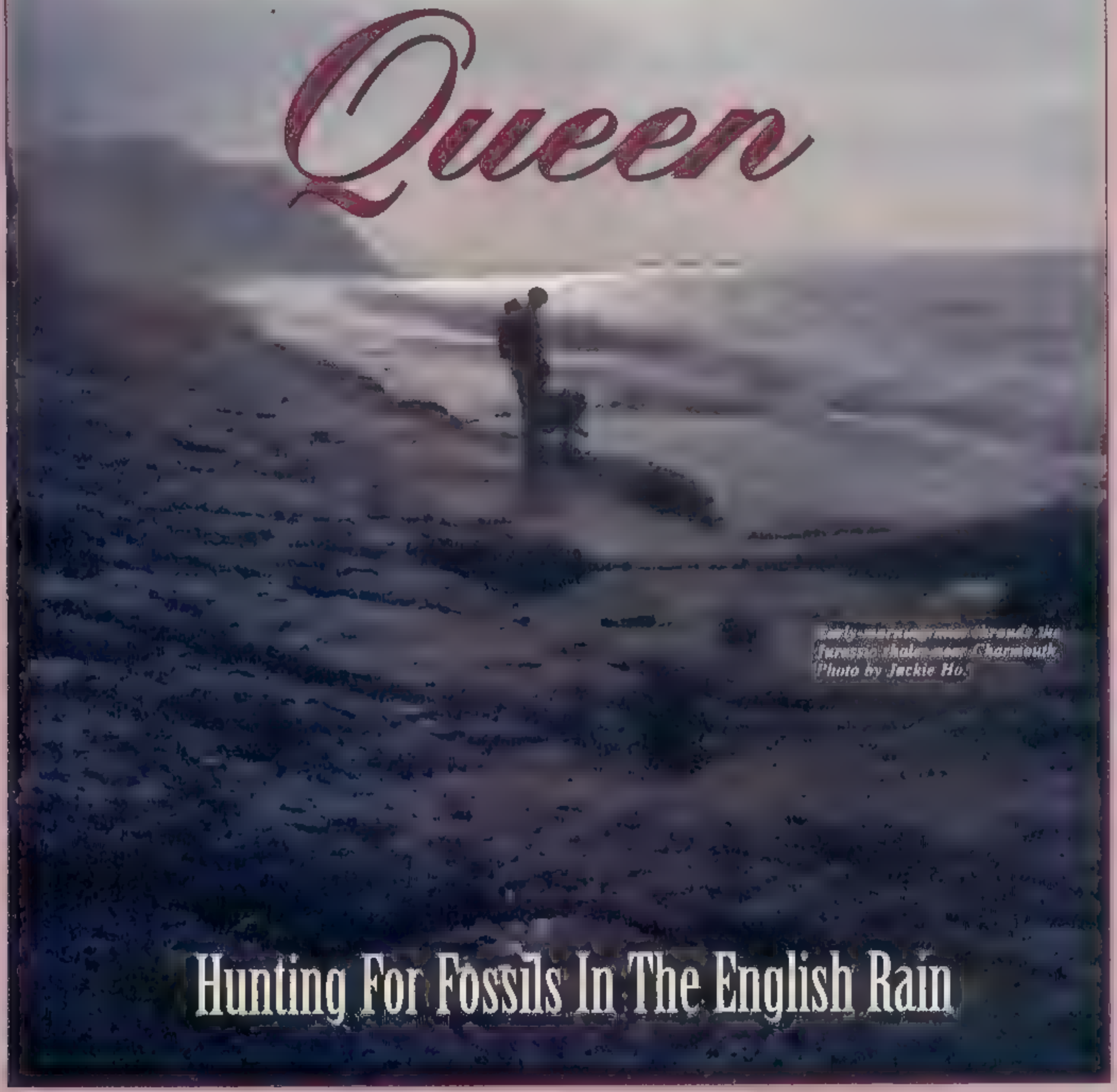
Tools Needed

- Screwdriver—Long handled, if you have one, for splitting open the layers.
- Rock Hammer—I usually don't recommend regular claw hammers, as steel is not made to strike chisels So using a chisel can create dangerous shards. But at this location, where you are merely tapping, a claw hammer will work if a rock hammer is not available.
- Plastic Bucket—A three- or five-gallon bucket works great for hauling out your loot. (Canvas bags or backpacks may tend to curl up, rubbing your specimens against each other and damaging the fragile millions-of-years-old material.)
- Pop Flats—Cardboard flats can be placed one on top of the other, each acting as a lid for the one below. Stacked flats are much easier to carry out, too.
- Newspaper—This makes a crisp wrapping material that helps keep the specimens separated and prevents them from being jostled around in your container.
- Paper Towels—You may wish to wrap the more delicate, loose pieces in a softer material before putting them in an outer, newspaper wrap.
- Zip-To-Close Plastic Bags—These also work well for protecting your delicate pieces. Just blow a puff of air into each bag in which you have placed a specimen before closing.
- Dental Picks—These tools come in handy for picking up overlapping layers of your fossils.
- Two-Inch Brush—Use a soft-bristle brush to help clean off the loose debris before painting fossils
- Clear Acrylic—Use two or three coats of spray paint, as it tends to soak in well. Painting with a brush would leave an artificial-looking, glossy finish.

I certainly hope that many of you will be able to make a stop here on your journeys around the county. I'm sure you'll have a great time and not go home empty-handed. Good luck with your collecting!



Chambers Fit For A Queen



Hunting For Fossils In The English Rain

Hildoceras ammonite from the Somerset fields, cut and polished to show internal chambers. Photo by author.

by Geoffrey Notkin

Most evenings began in the same way: After sunset we'd look for a country pub with an "Accommodations" sign out front. My girlfriend Jackie and I would be damp and covered with mud. I'd apologize in advance to the landlord, "Please excuse our disheveled appearance. We've been hunting for fossils in the rain." A round of smiles always followed, amid assurances that it didn't matter if we got the carpet dirty. Offers were made of help with our bags, which were, of course, full of rocks.

I spent my childhood in southern England, and my favorite early memories revolve around family expeditions to the south coast in search of ammonites—long-vanished chambered cephalopods from the Jurassic, but related to today's nautilus.

Enjoyable as our family trips were, we were not very successful at finding fossils. So, in March of this year, I set out with Jackie to journey through the country of my youth and, with luck, determination and umbrellas, find the ammonites that had eluded me as a child.

A band of Jurassic shales, ranging from 146 million to 208 million years old, runs in a diagonal line across England, from Dorset in the southwest, to Yorkshire in the northeast. The older strata, bluish in color, are known as the Lias. Inland, these fossil-rich layers lie mostly below the surface, but the narrow strips of coastline where they meet the sea make for excellent fossil-hunting localities.

Half a day's drive north of London, huddled in a steep-sided valley close to the Yorkshire moors, is the picturesque fishing port of Whitby. A ghostly abbey, ruined since the 1500s, sits starkly on the hilltop above the town, like the bones of a gigantic beached whale.

Bram Stoker stayed here, and set part of his novel *Dracula* in this town where the tombstones look oddly—not coincidentally?—like bats. Eccentric residents claim that Dracula really is buried up there in an unmarked grave. Whitby jet, a semi-precious gem much prized by local jewelers, comes from here.

Dactylioceras is Whitby's most distinctive fossil: a black, tightly coiled ammonite, preserved in hard oval concretions. The ammonites are more resilient to erosion than the surrounding rock is, and they weather into egg-shaped nodules that can be found at low tide. A careful (or lucky) blow with a rock hammer will split these nodules, revealing exquisitely detailed fossils.

We arrived in Whitby late in the day and immediately began our hunt, without thought of food or a place to stay. The rain had started, so we carried colorful, oversized golf umbrellas for shelter. We also took two buckets: one for tools and gloves, and a separate one for finds. (The Lias fossils are often coated with a slimy, viscous blue mud that clings terribly to tools and clothes.)

continued on next page

Top: The ammonites on Watchett Beach are quite fragile, but careful use of a hammer and chisel can bring them out in one piece. Center: The author cracking ammonite nodules at Port Mulgrave. Bottom: The author displaying the biggest specimen in the large haul of Somerset ammonites he and his girlfriend unearthed, which he is cleaning here. Photos by Jackie Ho.

Chambers/ *from page 73*

We clambered down the seawall and across the wet brown sand. The tide was far out, exposing great sheets of shale. "We're looking for oval stones," I told Jackie, "fist-sized or larger. The ones containing ammonites have a faint green cast."

Of course, the beach was littered with nodules. They're very hard, and it took much hammering to crack each one open. But hidden among the boulders were some stones with matrix worn down enough to reveal the sliver of an ammonite's outer coil

I traipsed up and down the edge of the bay, following a line of stones at the high-water mark. There were encouraging signs—fragments of broken ammonites—but nothing complete.

Jackie and I separated and, from time to time, I heard her rock hammer tapping in the distance. As the daylight began to disappear, Jackie walked up to me with a pair of symmetrical grey stones, one in each hand. She'd found one of the nodules, and by hitting the spine with her hammer, had split it almost perfectly into two halves: positive and negative imprints of the same fossil!

We started our next rainy day at the eclectic Whitby Museum, where an extensive collection of local fossils sits side by side with muskets, stuffed birds and nautical relics

Fossil hunting around Whitby is nothing new. Numerous holotypes have been found there since the 1800s. (When a new species is discovered, and its first published description is based on a single specimen, that specimen becomes the holotype.) And there were many on display, with obscure names like *Peronoceras turriculatum* and *Ovaticeras ovatum*. Other impressive local finds included five skeletons of the seagoing reptile ichthyosaur ("fish lizard") and a plesiosaur the size of a small whale.

Of particular interest to me was a detailed geological map from 1876, listing an assortment of fossil types and showing the exact location of each find. This antique map led us to Robin Hood's Bay, just south of Whitby.

Alternating layers of clay and shale along this section of coastline create a striking banded appearance. In areas that are predominantly soft clay, the sea has formed charming bays littered with rocks from the surrounding shales. Robin Hood's Bay is just such a place, dotted with red tiled, Mediterranean-style cottages

As the tide receded, we walked up and down the beach, cracking nodules ... and finding nothing

The cliff walls here are very unstable Yet, despite three rockfalls that afternoon, I saw a woman patiently picking through the fine shingle that had collected at the base of a 300-foot cliff

I asked what she was looking for. "I don't know how you call it in English," she answered in a strong German accent, showing me a container of crinoid stems. There were also gryphea and belemnites mixed in with the stones She stopped sifting long enough to show me her other finds: a couple of ammonites and one nautilus. "The best ammonites we find are farther north, at Port Mulgrave. You'll find many collectors there. Old folks with nothing to do go out at every low tide. But you will certainly find something."

We took her advice and followed a narrow country lane, through farmland, to a dead end atop a windswept cliff. The sea lay far below us, hardly visible through the rain and fog. We could hear breakers coming in, veritably cracking against the rocks.

"Could this be it?" Jackie asked. "It looks really far down to the water"

Yes, this was it, and it was low tide—the best time for searching. So we braved the steep descent, climbing down hundreds of feet with our tools and buckets, both of us repeatedly slipping and falling in the mud. We found ourselves wondering how the "old folks with nothing to do" could possibly manage such a trek.

Port Mulgrave is silent and deserted, but an article by E.J. Sandland, posted in the local pub noted that it was "...once a busy port from [which] Palmers Ironstone Company shipped its ironstone to the Tyne."

The boarded-up entrance to the mine can still be seen high up on the cliff face, but gone are the massive, elevated, iron railway towers. "All rusted away," one of the old locals told me. Only a few fishing boats and lobster traps remain

Within minutes of reaching the base of the cliff we began finding nodules with telltale ammonite spines showing. We searched among boulders and raked through shingle along the wide, half-moon bay until it was almost dark

Jackie and I covered opposite shores and, as I headed back to the cliff path at dusk, I saw her carefully picking her way toward me. She looked tired and cold. Her hooded jacket was splotchy with mud and water. She'd carried a heavy, loaf sized block of greenish slate a good half mile, from the far side of the bay, to show me

"I think there might be something in this one," she said. "I found it in a rock pool."

This "loaf" was too heavy to carry back up the cliff face, so I knelt down and braced it in between two large boulders. An unusually large ammonite spine snaked across its face, but there was no way of knowing if I would be able to break it cleanly in the fading light. I tapped the stone a couple of times and then hit it hard, immediately behind the exposed spine. Nothing happened. I hit it again ... and again. The fourth blow split the stone. Almost afraid to assess the damage I'd done, I carefully separated the two halves with my gloved hands. The shale had cleaved perfectly to reveal a marvelous *Dactylioceras*, with a cascade of spirals and ridges, jet-black and shiny like a giant millipede.

We spent that night at the nearby Ship Inn, where I sat up late with Sam Simpson, a retired fisherman -tall and contemplative, with sad eyes and long hair pulled back into a ponytail.

"When I was working, I'd see someone up on the cliffs—'rock-tappers,' we'd call

continued on page 76

Mother-of-pearl ammonites from the Wiltshire riverbed.

Chambers/ *from page 74*

'em, and we thought they were crazy. And now they come from all over for the fossils. The kids used to bring up bucketloads, and I'd just chuck 'em in[to] the garden. I knew one man who found a skull of a dinosaur or something up there. He said he knew where the rest of it was, but he was killed in a car crash and the secret died with him."

And there were other tales, as well. Two paleontologists were due in a few days, who knew the cliffs "like the backs of their hands." They'd apparently found 10 or 15 ammonites "like this," Sam said, curving his arms into the shape of a large dinner plate. "There [are] more up there, but it's too dangerous."

I believed him. I wanted to meet the paleontologists and see the skull and the rest of it, but we were moving on the next day. Sometime past 2 a.m. Jackie and I fell asleep with the laughter of Yorkshire fishermen drifting up from the bar below.

To my great delight, the next morning arrived sunny and warm. I crept out early, and rushed back down to the beach to catch low tide. The climb was far more pleasant in the sunshine, and in a short time I'd found several more nodules. I'd even been bold enough to go halfway up the "dangerous" cliff where Sam had seen the big ammonites. However, between the frequent rockfalls and the massive quantity of seagull droppings that rained constantly down from above, it was too risky even for a reckless enthusiast like me.

We spent the rest of the morning back in Whitby, walking along the rocks where Bram Stoker's fictitious ship, *Demeter* had been wrecked in the novel *Dracula*, and on up into the graveyard beside a ruined abbey.

Around A.D. 657, Abbess Hilda—later, Saint Hilda—became the source of an apocryphal tale explaining the origin of the many black ammonites littering Whitby Beach.

The myth is retold on a card in the Whitby Museum: *At one time, it was believed that ammonites were originally snakes that had been cast over the cliff by Abbess Hilda, using a magic wand. They lost their heads during the fall, and were turned to stone. ... In order to support this legend, obliging jet workers in the past carved heads on ammonites for sale to the unsuspecting. ...* An unlikely tale, but hundreds of years later, paleontologists with a sense of humor (or irony) named the ammonite *Hildoceras* after her.

Next, our journey took us south towards Dorset. For most of the way we followed the Lias, now buried far beneath us. But a glimpse into those hidden strata can be seen in a muddy farmer's field near Swindon, in Wiltshire, a couple of hours' drive west of London.

Although the Jurassic strata run some 70 feet below the surface, movement of mud and water in the area has brought unusual fossils close to the surface. Here, the Lias is softer and, over time, dissolves completely in water.

In the bed of a forgotten stream in the corner of a muddy field we found the most exquisite mother-of-pearl ammonites, perfectly preserved in the ancient mud. We had to stand knee-deep in cold water, our waders sinking into the soft bottom, and dig up heaps of sticky blue mud from the riverbed. At first we tried forcing it through a large sieve, but the mud was too viscous, so we shoveled it onto the bank and picked through it wearing rubber gloves.

Dozens of translucent auburn belemnites came out of the murky water, some of them several inches long. Every now and then, sunlight would catch on the pearlescent surface of a diminutive ammonite, illuminating it brilliantly against the wet mud.

The best Dactylioceras ammonites found by these two fossickers came from Whitby and Port Mulgrave. This and previous photo by author.

These are not stone fossils like those from the cliffs of Yorkshire. Here, we saw almost miraculous preservation of the shell itself. In those ammonites that had broken open we were amazed to discover chambers, not filled with limestone or crystals, as is the norm, but still hollow like they had been millions of years ago, when they were used to control the ammonites' buoyancy,...so many miniature submarines.

It was tremendously hard work, with each dense shovelful weighing 20 or 30 pounds. But we'd found a calm and serene place. We were surrounded by dense trees. The silence of the forest was disturbed only by the motion of the stream and a bird we couldn't see, who sang for us all afternoon.

Several hours' labor produced a half-dozen multicolored glimmering ammonites—each about the size of a stack of five dimes—and many fragments as well. We wrapped the luminous shells in tissue and plastic bags before heading back across the fields.

The following day, among low Somerset hills near the town of Ilchester, we caught up with the fossil-bearing rocks again, and this time they were almost at ground level.

Somerset is farming country, turning out much of England's dairy products and a strong alcoholic cider called "scrumpy." Orchards and small farms speckle the landscape. The villages consist of stone cottages with thatched roofs. In one particular area, where the Jurassic rocks are only a few feet down, it is possible to pick up fossils right off the surface.

Timing is everything, though, as the fossils appear immediately after plowing. New crops sprout quickly in this fertile soil, so walking the fields must be done after plowing, but before the appearance of fresh seedlings.

The fossils come from a yellowish sandstone that is quite soft and easily broken up by the plow blades. Our visit to Somerset was accompanied by fine weather, with the sunshine pinpointing hundreds of bright limestone fragments scattered across the dark, freshly turned earth. Fossil hunting had never been so easy or so pleasant. We followed the recently dug furrows, buckets in hand, stopping here and there to bend down and examine something.

Over time, farmers had amassed rock piles along the field's perimeter, and we picked through them in the hope of finding larger, complete fossils. Most had been broken into fragments, and details of others had eroded out of the soft sandstone. However, one of the piles yielded a perfect *Dactylioceras* almost four inches across.

In terms of size, species and geological period, it was almost identical to the best Dactylioceras Jackie had found a few days earlier in Yorkshire. But, visually, it couldn't have looked more different: My find was composed of soft yellow sandstone—a sharp contrast to the hard black specimens from Port Mulgrave.

The fields also produced numerous, small, worn examples of *Hildoceras*, the ammonite named after the Whitby Abbess. When cut and polished, these ammonites show a lovely, colorful pattern of crystallized chambers.

Only a short drive away on Somerset's north coast, near Watchett, the fossil-bearing strata stand on end, sticking out of the sand like plates in a dish drainer.

These great slabs are rich in ammonites and belemnites but, once again, the processes of fossilization have produced unique results. Paper-thin ammonites are visible almost everywhere, compressed by the great weight of now-eroded overlying strata. Exposed fossils have been worn by the sea, and are a dull orange, but cleaving the large slabs of shale might reveal brightly colored specimens.

continued on page 78

Chambers/ *from page 76*

They are fragile, but the colors are astonishing: rich blood-red, orange and violet, glowing in the sunlight like wafers of stained glass. They are difficult to remove from the stone, but we did manage to extract a few: Jackie by patiently tapping around one, and I by splitting large slabs with a mallet

After spending the night in a cozy, wood beamed 15th-century pub, we set out for our final destination: the beaches of Charmouth and Lyme Regis in Dorset. John Fowles made Lyme famous in his novel *The French Lieutenant's Woman*. Anyone who has seen the film of the same name will instantly recognize the stone breakwater that marches from Lyme Harbour out into the bay.

Like Whitby, Lyme is a gem of an old seafaring town. And, also like Whitby, the Lias is exposed here, shouldered against the sea in dark, fossil-laden cliffs.

Golden Cap, named after the bright sandstone at its peak, is the highest cliff on the south coast. Next to it is a dark, ominous hill with a unique place in the history of paleontology. It was under Black Ven, around 1811, that young Mary Anning and her brother found the first complete ichthyosaur skeleton. Although she had no formal scientific training, Mary went on to become one of the most successful early paleontologists. She continued her work and discovered the first plesiosaur. Her superb finds can still be seen today in London's Natural History Museum and in other major collections.

Many regard Mary Anning as the world's first female paleontologist, in an era when it was not seemly for women to pursue such things. She is something of a local hero, and postcards of her portrait are available in the fossil shops, along with beautiful pyritized ammonites, and the real prize—ichthyosaur remains—for which fossil hunters scour the nearby beaches.

Signs along the seafront warn, "The cliffs are dangerous. The best fossils are found on the beach." They are right, but it can be an arduous search. Several professional fossil hunters live in the area. Between them, and the hordes of enthusiastic schoolchildren who pour in during the holidays, there is much competition.

We stayed for several days in a delightful, secluded seaside inn: flower boxes in the bay windows and breakfast served in our beds.

Each morning I rose earlier, quietly slipping on my waders and layers of coats, trying to sneak out without disturbing Jackie. Those mornings were the highlights of the trip for me. The beach was empty, and the early-morning sun illuminated the sandstone atop Golden Cap. As the tide receded, I carefully picked through the beach pebbles, rich with iron pyrite deposits. Every now and then the sun would catch on something. I'd reach down quickly, before the sea could snatch it away from me, and pick up a perfect metallic ammonite: heavy and brilliant, like a brass coin.

In these sections of the Lias, iron has replaced the ammonite shells, transforming them into radiant natural sculptures. Most of them are small—it was rare indeed to find one larger than a 50-cent piece—but the weight and color made them particularly unusual and desirable fossils

The afternoons were spent sifting through shingle and examining large nodules for the ammonite, *Asteroceras*, often found in the area. Here, the nodules are harder than those in Yorkshire, and that's saying something! But even when an *Asteroceras* is found, it can require a good deal of preparation afterwards.

On my final morning, I went down to the beach well before 8 o'clock. As I waited for the tide to roll out, I shuffled along the slippery planes of the eroding Lias in my waders, thinking about Mary Anning and her ichthyosaurs. I wondered if she'd died embittered because her contributions to paleontology were not recognized during her lifetime. She had wandered along this very same stretch of beach, year after year, wicker basket and chisels in hand, doubtless alone

That image caused me to reflect upon the isolated nature of our work. Although there are societies and group field trips, for me finding fossils is often a solitary experience—a time for contemplation and perhaps even a little reverence.

The waves washed around my booted feet, sliding time and again over a dark object I barely noticed, that I took to be a thin piece of petrified wood. Eventually, another possibility crept into my mind and, casually, so as not to admit to myself what I was really thinking, I got down on my knees and peered at the piece of "wood." I was kneeling on an ancient Jurassic seafloor, so there could be no petrified wood here. In the layer of soft shale, just uncovered by the sea, lay ... an ichthyosaur rib!

Even with careful work, the ancient waterlogged bone came out in several pieces. But it was unquestionably part of an ichthyosaur, just like Mary Anning might have found nearly 200 years earlier

As always, it was difficult to turn our backs on the sea and return home, imagining what we might find if only we had "just one more day." We spent a final night in a rural Somerset inn. As we walked up to the door late at night, damp and dirty from the sea, carrying buckets of fossils, I smiled and gave my usual speech.

"Please pardon our appearance, we've been digging in the cliffs all day

"Oh, there's no need to apologize," the landlady beamed. "That's what holidays are for."

FOSSICKERS' TIPS FOR ENGLAND'S SOUTH COAST

- Almost every cove between Port Mulgrave and Robin Hood's Bay in Yorkshire yields numerous fossils, but some areas are remote and can only be reached by private vehicle. Ammonites are also found regularly on the public beaches in Whitby, a popular tourist destination, and well served by public transportation.
- The ammonite stream and Somerset fields are on private land, so permission must be secured to fossick there.
- Colorful ammonites are easily found along the beaches east of Watchett (near Minehead, in Somerset), embedded in large vertical sheets of shale
- The use of rock hammers is prohibited in some areas. Check with local authorities
- The beaches of Lyme Regis and Charmouth continue to produce great quantities of fossils—a fact well demonstrated by the number of professional and amateur collectors who frequent the area. It can be extremely crowded there during the summer months and on school holidays, so be forewarned.
- Fossil collecting on public land in England is legal (except in a very few areas, which are posted to that effect) and no permits are required
- Info at a museum and fossil shop on Charmouth Beach will show you what fossils to seek
- There are also two fossil shops in Lyme Regis, both with fine displays of ammonites and ichthyosaurs
- On a side street in Charmouth is the excellent Old Forge fossil shop and workshop, owned by one of England's foremost fossickers. Lucky visitors will be shown around the workshop where high-quality fossil preparation work is often being done
- The Jurassic cliffs in Yorkshire and Dorset are unstable and can be very dangerous. People have been killed in landslides and rockfalls; others have become trapped in the bays at high tide Be sure to consult tide tables, available at local shops and pubs, and use caution when working near cliff faces.
- For readers who would like more detailed information (including maps, and photographs) on the geology and paleontology of the Charmouth/Lyme Regis area, I suggest a visit to Graeme Caselton's excellent Web site at http://easyweb.easynet.co.uk/~gcaselton/fossil/fossil.html

Prehistoric fly trapped in amber from the Samland, photographed through a microscope.

The Amber

by Sam and Ruth Kirkby

To the mineralogist, amber is an oxygenated hydrocarbon with succinite. To the paleontologist, amber is a fossil resin exuded from an extinct prehistoric pine tree *Pinites succinifera.*

To ancient peoples, amber was endowed with a sacred significance. In the fairly recent past, amber was little used and almost unknown as a gemstone; however, it is currently experiencing a renaissance.

Many resins are misidentified as amber. True amber is a *fossil* resin. We are reminded of our Swedish friend, who once told us, "First you tell me it's 'yam,' then you tell me it's 'yelly.' " But that actually is the situation with amber: First it is a fossil resin and then it is a gemstone. The key to amber is that it does contain succinite. It also has specific characteristics that many other resins do not. The name "amber" should be reserved for the substance labeled "succinite" by mineralogists.

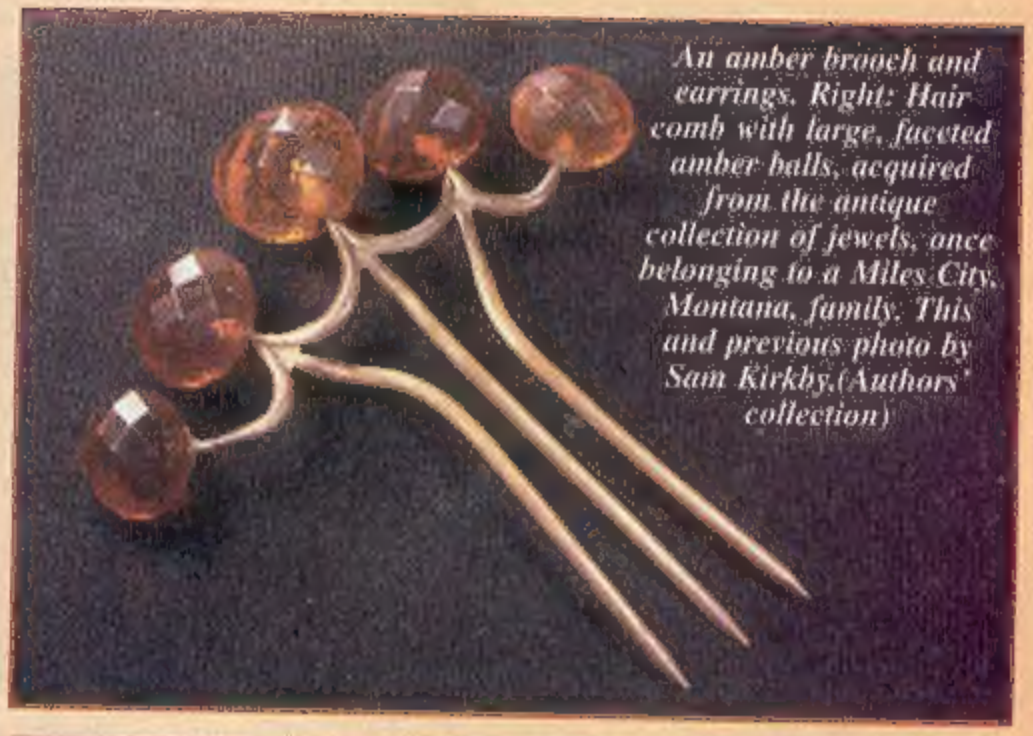
As far as we know, a complete analysis of amber has never been achieved. Dana lists its approximate composition as $C_{10}H_{16}O$, with some hydrogen sulfide. Most resins will dissolve with alcohol. Amber, on the other hand, is resistant. Upon heating, amber will decompose into the so-called "oil of amber" and a pitch-like residue. Dry distillation yields 3- to 8-percent succinic acid.

Amber is of truly ancient origin. Approximately 40 million to 50 million years ago, according to modern scientists, Europe had the aspect of an archipelago. Great forests grew on the shores of a vast primitive continent, it is assumed, in an enlarged area encompassing Finland and Scandinavia. This ancient continent is referred to as Fennescandia. The amber-resin producing forests were best adapted to a temperate climate with touches of subtropical temperatures here and there. Vast quantities of trees grow in these forests and, in the midst of these, many plants were *Pinites succinifera* or amber-resin producing trees.

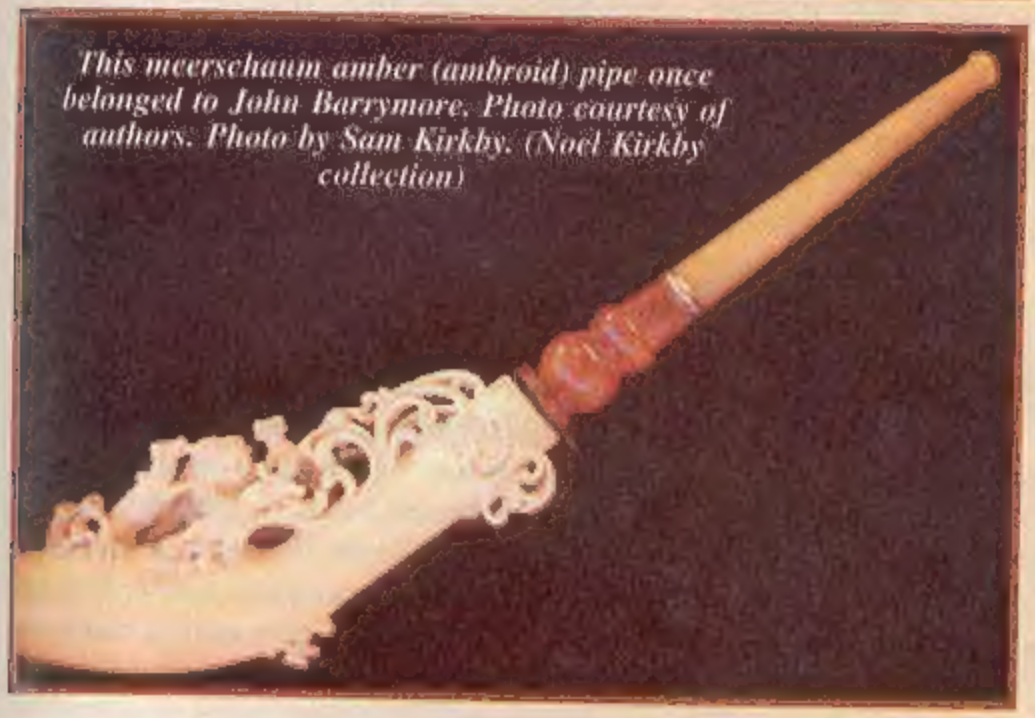
Plants grew lushly. And, as in all situations where there is an abundance of plants or other food, a great diversity of life forms was also in an profusion. Proof of the immense range and intensity of life in these ancient forests exists as the many inclusions that have been found in amber.

As in any forest, there was a relentless struggle for survival. Hundreds of pines in the forests died from insect attacks; the trees secreted resin in profuse quantities to try and drown the invaders—so much resin that many trees "bled" to death. Also, when there were bad storms, lightning killed living trees. The prehistoric continent of Fennescandia may have been the home for the forests that produced amber. All geologic evidence suggests just such a home for amber-producing trees.

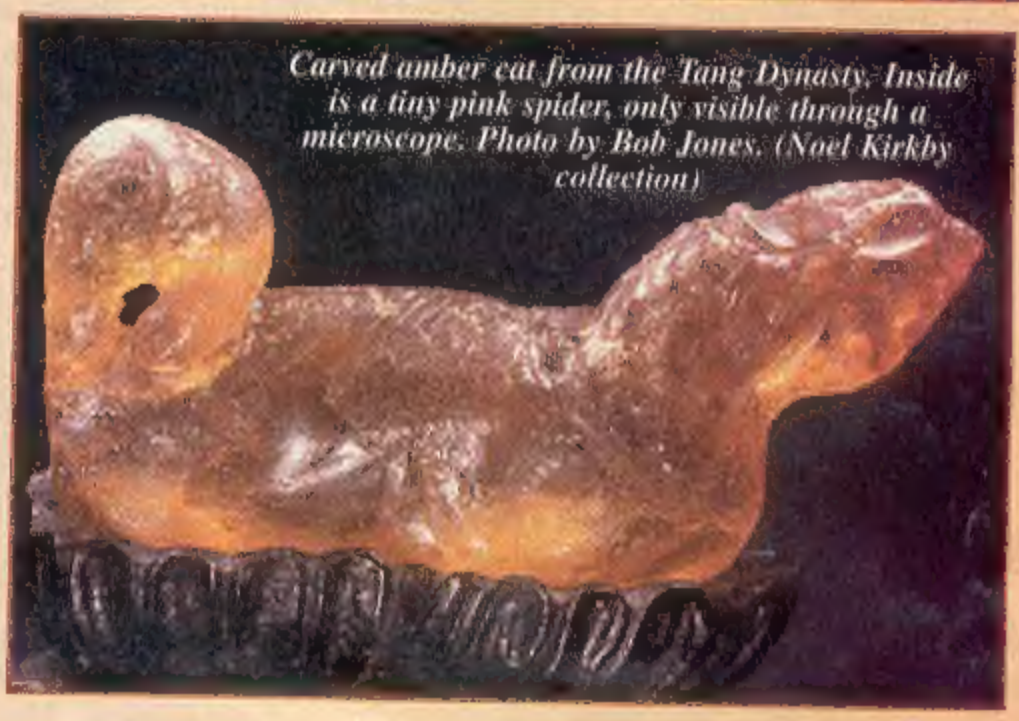
Because this continent disappeared, it is



An amber brooch and earrings. Right: Hair comb with large, faceted amber balls, acquired from the antique collection of jewels, once belonging to a Miles City, Montana, family. This and previous photo by Sam Kirkby.(Authors' collection)



This meerschaum amber (ambroid) pipe once belonged to John Barrymore. Photo courtesy of authors. Photo by Sam Kirkby. (Noel Kirkby collection)



Carved amber cat from the Tang Dynasty. Inside is a tiny pink spider, only visible through a microscope. Photo by Bob Jones. (Noel Kirkby collection)

Trails

The Fascinating Story Of The Fossil/Gemstone

assumed that, as the continent eroded away or subsided, the amber-producing trees were deposited in the bottom of the Baltic Sea. Because amber is lightweight and floats easily in saltwater (which has a higher specific gravity than that of fresh water), the amber would float to a tideless basin, especially when agitated during storms, to be deposited in the blue sands and clay in which it is found today. Over this layer of sediment, other layers built up over eons of time—some of lignite, striped sands and marls.

On the *north coast of Europe stands a* [illegible] called the Samland. It looks [illegible]

of Earth's most restless seas and its present coastline is the most unquiet, geologically speaking. Erosion constantly washes out layers of the blue earth containing amber. Being tossed about by the waves, amber may rest on a raft of seaweed and be carried to the beach, where man can find it.

Primitive people collected amber along the Baltic coast. It must have helped satisfy their craving for beauty. Also, they endowed it with sacred importance. Man's highest achievement is art, *and prehistoric art furnishes the oldest* record of man's presence on Earth. Carv[illegible]

uine amber, it had to come from the Samland.

In the Bronze Age, amber became a commodity to be traded with the South and the West. Amber was responsible for the high level of culture in the Baltic region. This product of nature was the determining factor in the development of civilization along the Baltic shores.

The Bronze Age was symbolized by bronze arms and sacred amber: two means of defense—the one physical, the other spiritual. But Bronze Age man *needed tin to survive. It came from a far* distant corner of Europe: England, the [illegible]

Amber Trails/ *from page 81*

The source of tin was a closely guarded secret. As a result, there was much competition among tin traders. Early traders made secret journeys and concealed their routes. But the fact that tin made its way to workshops in the Mediterranean region pays homage to the persistence of those who traded in tin.

Early trade routes are obscure, but the work of many archeologists has traced the graves lining the paths of these ancient pioneers. It took courage to travel to an unknown destination for amber and to bring it back to the more populated and civilized Mediterranean area. Because that part of the world was, as yet, unmapped, wily traders, who were businessmen after all, had no desire to give up their secrets. The traders described the locations to the north as areas populated by barbaric tribes just to frighten off would-be competitors. Rivers were important to the growth of civilization, but trade routes could not follow rivers because of the mountain ranges through the middle of Europe. But amber was popular, so its traders suffered the hardships of travel through those mountains to reach the Baltic Sea. They carried amber south through the Mediterranean, west through France to Spain, then to the Near East and finally to the Far East.

The ancient Romans' proclivity for luxury created a market for amber, but Greece shares honors here because the Greeks were incapable of keeping the peace and, through their wars, could have destroyed their own cultural glory. But Rome saved the legacy of the Greeks. Romans appreciated the cultural superiority of the Greeks and assimilated Hellenic thought and art into their own culture. So Greece, the creator, was saved by Rome, the preserver.

This Greco-Roman culture was the basis for the development of the Roman Empire, and was followed by centuries of peace and prosperity. During the Golden Age of Rome, Africa sent forth ivory, from India came pepper, Southern Arabia produced frankincense, China sent silk and from the Baltic came amber.

In 1394, a Konigsberg (what is now Kamliningrad, Germany) charter made it unlawful to possess or acquire amber. Simon Grunovius' 1677 writings tell us that inhabitants of the amber coast were required to fish for amber under taskmasters appointed by the government. For every bushel of amber collected, the remuneration was a bushel of salt.

This work was very hazardous and sometimes required the efforts of an entire family to be able to collect one bushel. They used a long pole with a hoe-like base to rake the sea floor and agitate the debris. Then they collected the floating materials for further sorting in order to recover the amber. Many lives were lost due to this method of recovering amber.

During the Middle Ages, there were struggles between the Poles and Prussians. Struggles meant oppression, inhuman slaughter and the denial of basic human rights. Amber became monopolized by the government, and possession of it meant death by hanging. The government sent all amber some distance away to be worked into rosaries. This was done so as to discourage local residents from unlawfully possessing amber.

In 1854, an innkeeper at Memel (now Klaipeda, Germany), a city located at the north end of the Kurisches Haff, leased the right to dredge the sand from the estuary and to dump it on the Nehrung, where thousands of people found work sorting the amber. By 1860, this innkeeper had formed a partnership with a certain Mr. Becker. They operated a successful business until about 1866, when the harvest was most disappointing. In 1870, they hired a geologist to test the possibilities of mining amber on the Samland, near Palmnicken.

Because former surface operations had been unsuccessful there, they ran borings to see to what depth they should go. These "modern" methods were successful and they used a digging ladder or bucket brigade to bring the earth-covered amber to the surface. They stirred the heaps of earth into thick mud, washed it under a high-pressure hose and then sieved the whole lot.

About 20 percent of this amber was suitable for jewelry. The rest was saved for further sorting. Specimens with inclusions were sent to Albertus University at Kamliningrad. Sadly, over 70,000 specimens would be destroyed by fire during World War II.

Some amber has been found in the south of France and near Suffolk, England, but not in commercial quantities. The abundant supply of amber has been in Prussia, and the people of that region have suffered greatly due to extreme measures taken by the government because of this wonderful material.

Amber has been used for rosaries by Muslims as well as Catholics. One of the oldest guilds for the makers of rosaries was located at Bruges in northwest Holland. This lovely material has also been used for many decorative purposes because of its glittering golden color and light weight. Its main use has been in jewelry, but it was even used to decorate bed covers. Also, wealthy Roman ladies carried large balls of amber to remove lint from their gowns because of the static electricity it developed when rubbed.

In China, it was considered a symbol of power and wealth to burn expensive amber as incense, a procedure which also helped to mask the odor of poorly kept food. The Chinese also were the first to use a lathe to turn amber when preparing to carve it. Many of their carvings were made to honor Chinese deities, and are now considered a major source of artistic information about ancient Chinese culture and religious practices.

A Portuguese Jesuit priest reported finding amber in Yunnan Province, in Burma. "It is digged out of mines in great pieces, but is not so cleane as ours, yet redder," he wrote, in the style of the times.

Burmese amber is regularly mentioned by traders and historians of the time. This amber is called Burmite, and contains succinite. Ruth once owned a lovely necklace made from Burmese amber that had been carved; however, it was destroyed in shipping.

Our son, Noel, was fortunate to receive a gift of an early amber carving when he was traveling in the Orient. It contains a tiny pink spider that can only be seen when examining the piece under a dissecting microscope.

Cloudy amber contains numerous microscopic bubbles. It can be cleared by boiling it for a long time in oil—preferably, turnip-seed oil. Amber will soften when heated to 160 degrees C, and can be combined with other pieces of amber under pressure. Then it is called ambroid. Pipe stems are made from ambroid.

Since earliest times, other fossil resins have been sold or traded as genuine amber. Whenever you see a large specimen encased within the resin, be aware that it may not be genuine amber. A relatively large creature could escape the resin, while a small insect would be trapped when its appendages or wings were caught in the sticky stuff, which sometimes pulled off its legs or wings. Strange as it may seem, the surest way to identify genuine amber is from inclusions of plant "hairs" or blossoms from an oak tree.

If you think you have a fake insect specimen, look to see if it is perfectly arranged in the resin or how twisted it is by having tried to free itself. Any insect will try to get away when caught by resin. If a specimen is arranged nicely and more resin has obviously been poured over it, you can be sure it is not a genuine fossil amber inclusion. Amber does not melt and then return to its former quality.

Amber is a good medium for illustrating static electricity, as alluded to above. By rubbing a piece of amber, you can create electricity that will pluck up small pieces of paper. But other fossil resins and even plastic will do the same.

A large supply of fossil resins besides amber have come on the market during the past few years, which also contain fossil insects. Some of them are beautiful, but not a match for true amber.

The same old wives' tales about the

power of amber are being told today about these new resins: that they are cures for rheumatism and goiter, even a "cure" for an unfaithful wife (whatever that means).

If you are lucky enough to have some genuine amber, take good care of it between wearings or uses by storing it in oiled paper. If you don't take this precaution, a crust may form on it. Then the only way to restore your amber is to resand the surface and polish it anew. We keep our collection of amber in a wax-lined box, and when one of us needs to remove a piece for some purpose, the oil is wiped off the specimen to enjoy the beautiful golden gleam again.

Although, over the years, our collection of inclusions in amber has grown to several thousand pieces, there are a few specimens that we really treasure. One is a tiny meerschaum pipe that belonged to Ruth's paternal great-grandfather. The bowl is carved and a pewter band holds the amber stem. Other special pieces include the jewels from a Miles City, Montana, family: a lovely comb with long slender teeth and five, large faceted balls; earrings; and a beautiful brooch made with faceted balls of amber. Another treasure is a long pipe that once belonged to John Barrymore. It came into his possession while he was traveling in Italy, but now rests in our son's collection!

Of the many fossil insects encased in amber, each one telling something about the environment at that time, we find many that intrigue us because of the stories they tell. One is of a fly that has a passenger on one of its wings: a microscopic mite that shows up well when photographed through a microscope.

We treasure the quaint little book that we received as a gift from Dr. Wonnecott, of the British Museum, in 1959. It is illustrated with unique figures. Titled *Amber, All About It*, the book was published by the Office Of Cope's Tobacco Plant, of Liverpool, England, in 1891. There are many intriguing stories in this book and the front and back covers are illustrated with interesting sketches.

During the early '50s, we were doing a project on the background of amber and the fossil resins. When we discovered a new bookstore, we would inquire if it had any publications on amber. Generally, the proprietor of each new bookstore would reply, "Yes, we have *Forever Amber*." How shocked we were that a famous novel could be considered by any person learned enough to run a bookstore to be about the wonderful fossil, amber!

Now that you have read and, hopefully, enjoyed this article on amber, we hope that you will come to appreciate and enjoy it as much as we do. And the next time you're in a bookstore, maybe you can teach the staff a thing or two.